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ORIGINAL ARTICLES

THE ORTHODONTIC TREATMENT OF ADULT CASES*

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TRAUMATIC occlusion is now generally recognized as an important factor in the etiology of the various forms of periodontal lesions. The present conception of periodontology, although of comparatively recent origin, has greatly clarified our knowledge of these pathologic conditions and has already established itself as one of the fundamental subjects of dental practice. Periodontology concerns all branches of practice most intimately and no dental operation can be properly undertaken unless its principles are understood and adhered to. According to present knowledge, the etiology of periodontoclasia or periclasia (to use the abbreviated term) is due to a complexity of factors. These have been divided into two groups—inaugurating (which may be likened to primary) and noninaugurating (which may be likened to secondary). Of the inaugurating, malocclusion is among the most important and many consider it to be the principal one.

The metabolic disturbance, for which this condition is responsible, results in changes which may be deferred or rapid according to the response to injury possessed by the tissue cells of different individuals; likewise the extent of the lesions will vary. It is well known that the periodontium (mucous membrane, pericementum, alveolar process) of two individuals, each of whom presents an apparently similar occlusal abnormality, will often develop dissimilar lesions during the same period of stress. No satisfactory explanation of this biologic problem has yet been offered. Endocrinologists hope to prove their theory that it is caused by a calcium deficiency in the tissue cells of the entire periodontium, while immunologists, on the other hand, contend that it may

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come about through the establishment of a more definite knowledge of cell resistance than is now known.

Whatever it may prove to be, it is generally recognized, by periodontists that all cases of traumatic occlusion do not produce like lesions in all individuals. There are those whose tissues show advanced lesions at an early age, which result in congested gingivae, marked pericemental and alveolar disintegration; while the gingivae of others, in late middle age, are of good tonicity, with slight tissue wasting and whose alveolar processes and pericemental tissues are practically in the same state as one may see in cases of natural atrophy, which is the concomitant of age.

It is the former group of cases which offers a real problem to the periodontist. Young adults whose ages range from twenty to twenty-five years and some even younger, are treated by him and complain of pronounced discomfort, such as severe gingival hemorrhages whenever the teeth are brushed, fetid breath and pus-pockets; a condition which allows food particles to pack in the interproximal spaces. This condition of pocket formation is called suppurative periodontoclasia or pericementoclasia. Other patients show a progressive recession of the gingival tissue which exposes the cementum and causes it to become eroded and hypersensitive. There is usually no apparent gingivitis in these cases and no pocket formation. This condition is called ulatrophia, and is treated somewhat differently from pericementoclasia.

In all these conditions there is malocclusion more or less pronounced which is usually amenable to treatment by the periodontist if the occlusal disharmony is not too marked and the case not hopelessly advanced. Judicious grinding, the insertion of inlays by a competent operator, which will restore deficient occlusal or approximal contact surfaces, is the usual procedure in cases of ulatrophia, and this treatment combined with apoxesis and proper use of the toothbrush usually gives favorable results in cases of pocket formation. When the malocclusion is unusually pronounced, such as is seen when there is a marked lingual inclination of the maxillary incisors or other decided abnormalities, the problem becomes complicated and can only be solved by the joint services of an orthodontist and periodontist, because grinding alone will not satisfactorily relieve the trauma present.

When I was a student some twenty-three years ago, it was the custom to treat adult cases of malocclusion which gave promise of responding favorably. Some years later a change developed in orthodontic thought and only very young children, preferably those under the age of twelve, were considered the best subjects. About this time the profession began to hear the term "the orthodontic age" and many orthodontists refused to treat cases unless they were within this limit, a practice which is still maintained by some.

The problem has changed since then, principally because the knowledge of tissue degeneration, as the result of traumatic occlusion, is so general. It is well that those who practice orthodontia only for the young, should realize that something must be done to help those patients who otherwise have many years of physical discomfort and unhappiness to face as the result of the absorption of toxic matter often present in these cases. It may be a bold statement to make and one that is open to a great deal of criticism, but for the sake

of the patient it would often be far better to extract such teeth as soon as the early lesions are seen than to neglect them in this way. I often wonder if operators who refuse adult cases would allow a similar condition to exist in their own mouths without making some effort to check it. While periodontists are aware of their inability to judge whether or not a case which is beyond the orthodontic age will give promise of responding to regulating services with a marked degree of success, it seems probable that there must be many cases which will do so if the work is carefully and intelligently carried to completion. A prognosis of this kind, like any other that concerns bodily functions, must be influenced by factors which only those who practice orthodontia constantly are capable of understanding. It is realized that the question of ultimate success of treatment is complicated by factors which do not enter into cases of young patients.

On the other hand, it is well known that there are many cases included in the so-called orthodontic age, which do not yield the results hoped for when treatment was begun. Periodontists see many of these later in life with finished results that are far from satisfactory from an orthodontic viewpoint and periodontoclasia in many forms is present, often to an alarming degree. This statement is not meant as a criticism of the orthodontist but is made rather to stress the fact that age in itself is not a fundamental requisite for success.

With this thought in mind, the writer thinks that many adult cases in which cooperation by the patient is cheerfully given (a factor which is often lacking in many children's cases) is of much assistance in treatment, providing of course that other conditions are favorable, in the opinion of the orthodontist. Adults who are brought face to face with the realization that ultimate loss of their teeth will surely result, if radical steps are not taken to counteract the pathologic condition present, will give an amount of cooperation of which but few children are capable. If such cases are undertaken and the work slowly done, with both orthodontist and periodontist conferring constantly, many patients neglected today would receive great benefit.

As a working knowledge of periodontology is of unquestionable assistance in the consideration of these cases it may be well to consider some periodontal facts which will be of assistance. All adult cases should be carefully studied from an orthodontic and periodontal viewpoint and none should be begun until a full set of roentgenograms have been carefully studied. As an example, a young woman of twenty-one was referred for treatment of periodontal pus-pockets. She was wearing an orthodontic appliance at the time, and her case history disclosed that it had been worn but a short period.

The operator who had charge of her case was particularly gratified that the right maxillary canine had moved with much ease in a short space of time but an examination of the roentgenograms showed that over half the pericementum and process around this tooth was destroyed, a fact which accounted for the ready movement. When this was shown to the operator and the case discussed, he immediately ceased using force and substituted a retaining appliance for the original. An example such as this illustrates plainly why one should never undertake to regulate an adult case unless roentgenograms are

studied carefully because cases that show a marked alveolar disintegration have a very doubtful prognosis. An adult of twenty-one or even one of twenty-five years whose periodontal tissues disintegrate as rapidly as this, is a poor subject for orthodontia. Cell metabolism in these cases is low and the resistance to injury is weak. The force exerted by an appliance is but an added factor, for it accelerates cell injury and hastens the mobility of the teeth and their eventual loss. On the other hand, all other factors being favorable, those cases in which the alveolar wasting is not so marked will respond usually to proper treatment.

At a talk given by an orthodontist recently some photographic slides of unusually fine results obtained in the treatment of adult cases were shown. The patients were apparently treated just as children would have been and no roentgenograms were used as a guide. As a consequence, the operator could not have been cognizant of the condition of the deep periodontal tissues before, or after treatment. The sole idea in treatment, apparently, was to bring the teeth into good alignment and to create a more pleasing esthetic effect.

As near as can be recalled, the factor of creating better function during mastication was not stressed, although it must have been considered, and only a passing reference was made to the condition of the alveolar process or the pockets which were present. No mention was made of an effort to relieve the periodontal irritation and it may be properly assumed that it was not done. That this was a serious omission cannot be questioned. An inflamed gingiva always indicates a local or general disturbance of the periodontium and unless corrected and proper mouth hygiene maintained by the patient, the orthodontist's results will be of temporary benefit.

Cases such as these indicate a lowered tone of the cells of the gingival tissue and often the presence of calcific deposits, which are responsible for the congested, thickened and discolored appearance seen. Should the detachment of the gingivae be over 2 mm. in depth there is an added involvement, namely, pocket formation and the presence of detached pericemental fibers and root deposits. Bacterial invasion which follows the initial irritation is responsible for the morphologic tissue change and the accompanying disintegration. It is apparent, therefore, that orthodontic treatment is not sufficient in itself to properly correct the abnormality.

I have knowledge of two adult cases whose ages were eighteen and thirty-one years respectively (Cases A and B). The former had a distressing experience as a child and was forced to discontinue orthodontic measures after a short period. Both A and B were cases which no periodontist could treat alone with any assurance of success on account of the malocclusion present but a careful orthodontist has accomplished marked changes for the better. Case A is as yet uncompleted. Case B was carried out without the use of labial wires, a condition exacted by the patient before she consented to begin the work. Periodontal treatment was given to each during the regulation period. Roentgenograms and casts were studied and the former will be compared with others to be taken later, from time to time, in order that the condition of the osseous tissue may be observed. In addition to this, there is recorded a case history of each as is usual in periodontal practice. Thus a

complete record of both cases will be available for future reference whenever desired.

The problem of maintaining good mouth hygiene both during and after orthodontic treatment is one of greatest importance, particularly in adult cases. Periodontal lesions will never heal regardless of the amount of care and skill which the operator may contribute as his share of the work if mouth hygiene is neglected. Food particles which are allowed to remain on the gingivae are a mechanical as well as a chemical irritant, mechanical because of their contact with the tissues and chemical because of the action of the mouth bacteria which results in fermentation and putrefaction. No adult should be treated unless this is explained by the operator and understood by the patient. Bacterial plaques which are not entirely removed from the tooth surfaces because of poor brushing are also a source of chemical irritation to the gingivae, to which is added the accumulation of calculus, which introduces the mechanical factor as well, as the incomplete brushing is continued. The value of maintaining good tissue tone of the gingivae during and after the completion of the treatment period is recognized by all periodontists and is impressed on all patients.

More orthodontists would do well to acquaint themselves with the different methods of toothbrushing and gingival massage as well as the proper shape and size of the toothbrush, for a condition of oral health is such a vital necessity in their work that no detail, no matter how small it may appear to be, can be neglected if complete success is to reward their efforts. It is to be hoped that more adult cases will be treated in the future than at present, because by doing so the health of many who might otherwise be denied this help will be much benefited and their bodily comfort thereby improved. It is hoped also that orthodontists will give this problem more of their attention and study which will include a combination of the esthetic and functional factors and a consideration of the most important of all, namely, the improvement and preservation of the entire periodontium.

A METHOD OF PREDETERMINING TOOTH MOVEMENT AS AN AID TO DIAGNOSIS AND TREATMENT OF MALOCCLUSION

By Jos. E. Johnson, D.D.S., Louisville, Kentucky

I DO not think it necessary for me to go into the history of arch predetermination, as I am sure you are all acquainted with the work that Hawley, Stanton, Gilpatric, Hoggan and Hanau have done along this line.

Fig. 1 is a front and side view of the trays used in taking the impression. These trays are very shallow, having just enough depth to cover about two-thirds of the crowns of the teeth.

S. S. White impression tray compound is used to take the impression. (Fig. 2.) I find that this compound sets quicker, gives sharper lines and pulls less than any other make of compound.

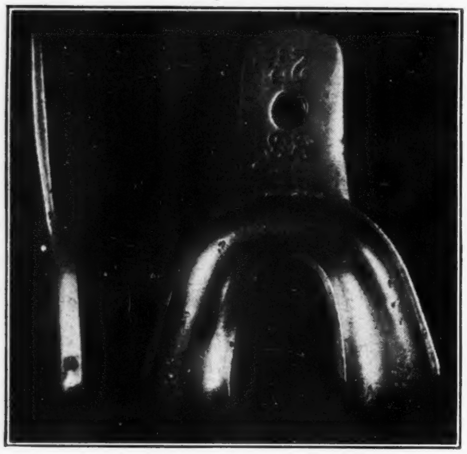


Fig. 1.

The following technic is used in its manipulation: The compound is heated in water until it is quite soft; the tray is also heated so that the compound will adhere to it. The compound is then placed in tray, the back of which is passed under a stream of cold water; then compound is passed through a Bunsen burner flame until it is quite soft, and then inserted into the mouth. The impression is taken in the usual way. I have found it necessary to use this technic or otherwise a poor impression will result on the lingual of the maxillary, for since there is no palate in the tray, the compound will flow away from the teeth. I take a wax bite, that is, I have the patient bite into a piece of plate wax, and I also measure the distance between the head of the condyle and mandibular central incisors. I will show the need of this later.

The median line is registered at this time, the appliance in Fig. 3 being used to obtain it. It consists of a headgear and frame. The latter is held in position on the face by means of a set screw on the headgear. At the top and

bottom of this frame are adjusting screws, to the end of which is stretched a fine wire. A small rod in the middle of the frame prevents the wire from pressing on the nose. To obtain the median line, the fine wire is moved back and forth by means of the screws until it is in the middle of the face, *B,* Fig. 3.

The patient is then instructed to throw the head back as in *A,* Fig. 3. If the wire passed between the central incisors, we know the median line is

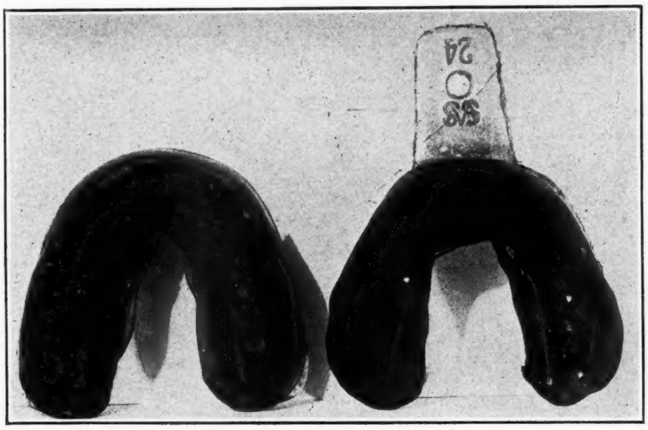


Fig. 2.

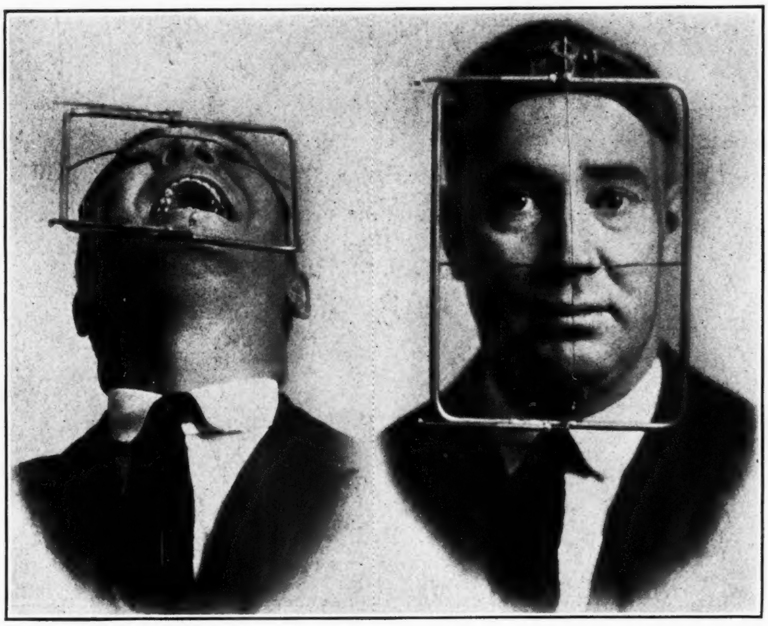


Fig. 3.

correct. If it does not, the median line is marked on the tooth with a lead pencil and the difference measured with the dividers and registered on a cork mat.

Since we only need the crowns of the teeth, the next step will be the cutting down of the impression. This is done by the means of a wood file or an ordinary grater, Fig. 4. I prefer the wood file.

Fig. 5 shows the impressions after they have been cut down. In the left

hand tray, you will notice that the position of each tooth has been marked on the compound; this is done so that when the impression is packed with amalgam we are able to place the pins in the proper place in the amalgam teeth. It takes from $\frac{1}{4}$ to $\frac{3}{8}$ oz. of amalgam to pack an impression. The alloy is

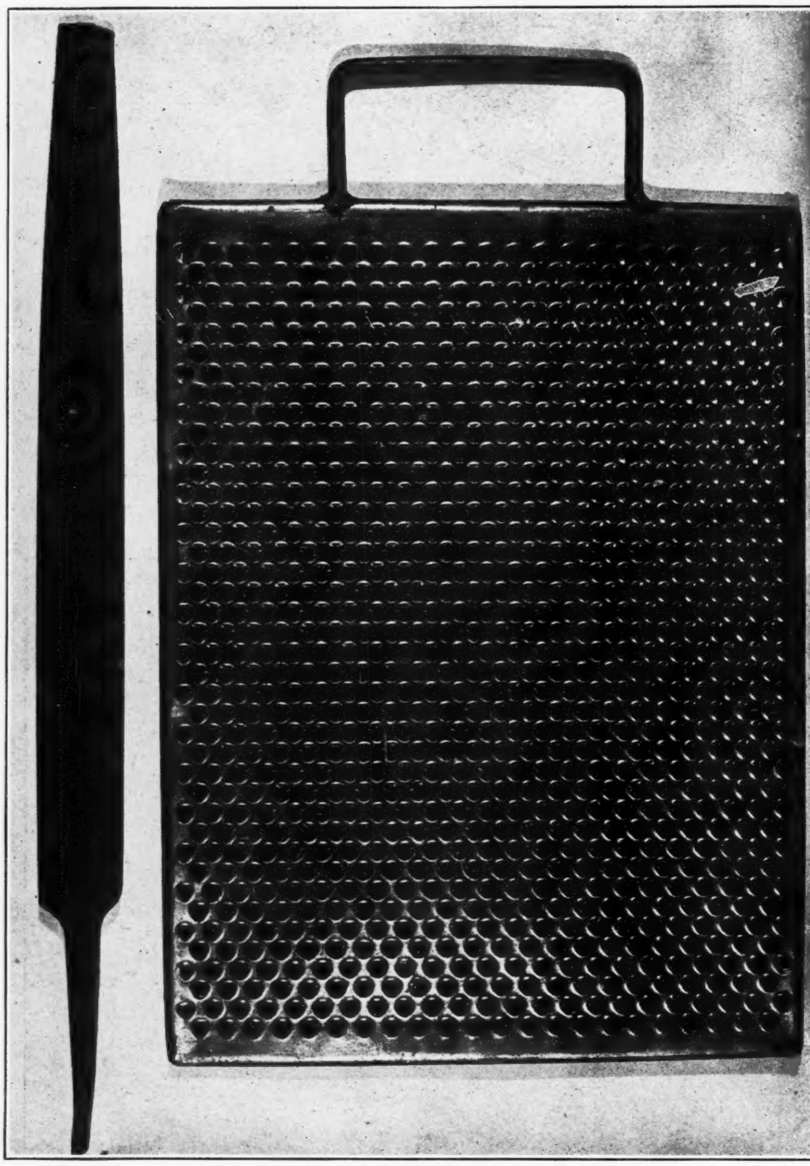


Fig. 4.

weighed and an equal amount, by weight, of mercury is added. The amount of mercury, of course, depends on the kind of alloy used.

This amount of amalgam is too bulky to mix with a mortar and pestle, so I have devised the amalgam mixer shown in Fig. 6. It is a brass cup soldered to a piece of spring steel, one inch wide and ten inches long. The steel strip is fastened to the wall by means of a bracket which permits it to rest on an eccentric wheel attached to the lathe. When the lathe is running, the

off-center wheel causes the cup to vibrate very rapidly. This mixes the amalgam usually in one-half minute.

In Fig. 7 we have the impression packed with amalgam, and the pins in the teeth; each tooth has one pin, except the molars, which have two.

Fig. 5.

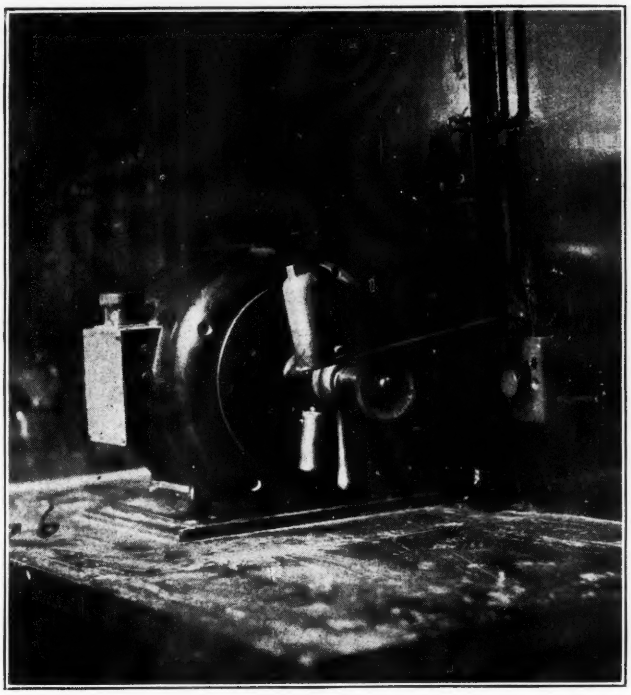


Fig. 6.

The pins are made by flattening out the ordinary pin by rolling or hammering. (Fig. 8.) Flat pins are used so that the teeth will not rotate in the cork mat. They are used in three lengths, $\frac{4}{16}$, $\frac{5}{16}$, $\frac{6}{16}$. The heads are turned outward on the six anterior teeth and inward on the premolars and molars.

The pliers in Fig. 9 are used to insert the pins into the amalgam. They

have a groove in one beak which prevents the pin from wobbling when it is forced into place. The other two instruments in Fig. 9 are used to pack the amalgam into the teeth.

The amalgam should set two or three days; it is then ready to be transferred to the cork mats. (Fig. 10-*A*.) This is ground cork table mat which

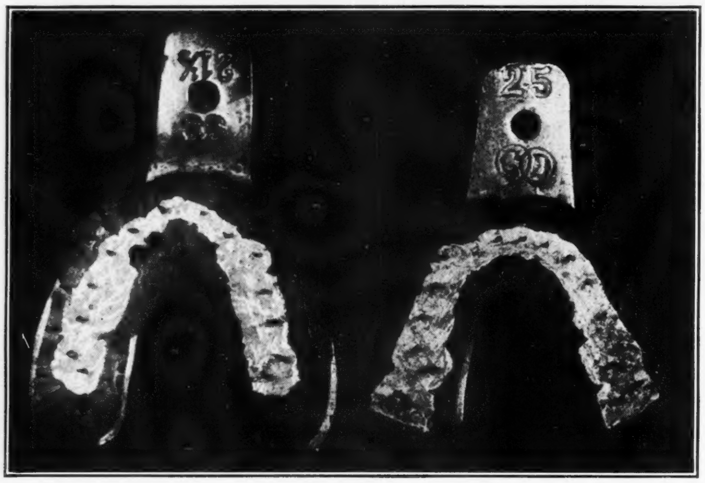


Fig. 7.

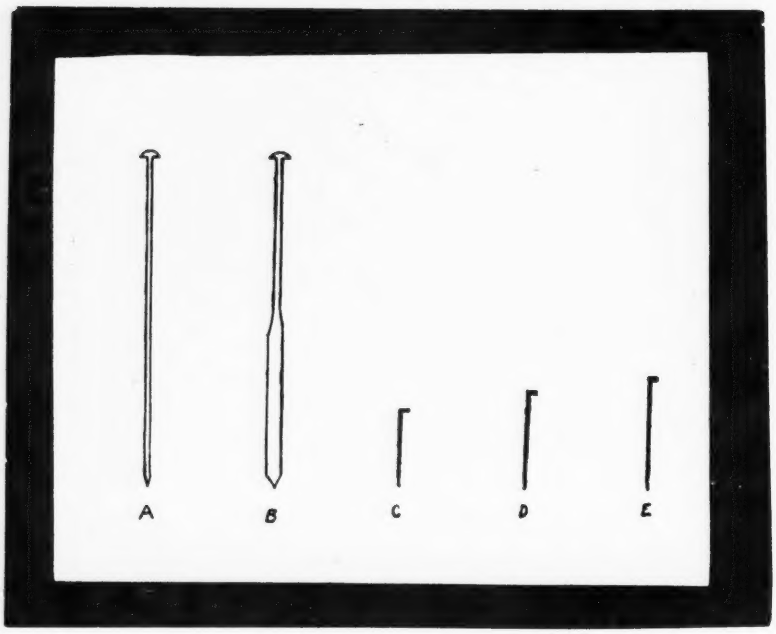


Fig. 8.

is cut to the required size and shape and on which is pasted a piece of drawing paper. (Fig. 10-*B*.)

The impression, packed with amalgam, is now pressed down into the mat. It is very important that the impression be kept in the tray, to prevent breaking of the models when forced down. (Fig. 11-*B*.) The tray is removed and the compound is chipped off the amalgam model with a knife or other

sharp instrument. It comes off very easily and there is no danger of breaking the amalgam teeth. (Fig. 11-*A*.)

The teeth are now removed from the cork mat and are trimmed around the gingival with knife edge carborundum stone. (Fig. 9.) I break the teeth apart, care being taken not to destroy the contact point. The lingual and buccal grooves of the molars are deepened with a fine jeweler's saw. The teeth are then replaced on the mat, Fig. 12, and a hard drawing pencil is used to trace the position of the teeth on the mat. Lines are drawn from buccal and lingual grooves of left molar to the buccal and lingual grooves of the right molar. If these teeth are in normal torsi-relation to each other, the lines will be parallel. Fig. 13 shows the tracing of the teeth on the mats.

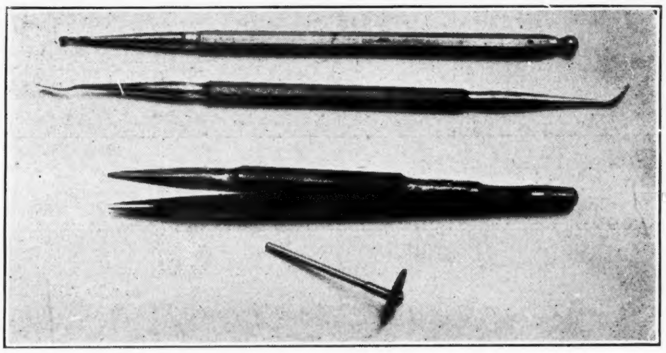


Fig. 9.

A *B*

Fig. 10.

We are now ready to place the models in the articulator. Fig. 14 is a Snow articulator. Any anatomic articulator will do, I just happened to have this one. To the upper bow, I have attached a plate with a ball and socket joint; this permits the upper plate to fit flat against the cork mat. To the lower bow of the articulator, another plate is soldered. Both the upper and lower plates have threaded pins soldered into them. These pins hold the cork mats to the plates.

Fig. 15 is a side view of the articulator with models in position before the wax bite has been removed. The bite is necessary to hold the models in normal relation to each other when placed in the articulator.

In Fig. 16 the wax bite has been removed and we are now ready to predetermine the tooth movement.

I have no fixed formula in moving the teeth. My plan is to move them into what I think is normal occlusion with the least amount of tooth movement. To do this, I take into consideration the profile of the patient, the class of malocclusion, the etiology, if apparent, the median line, and the overbite, etc.

A *B*
Fig. 11.

Fig. 12.

Fig. 13.

I will now show several cases of predetermined tooth movement and will try to explain why I have moved the teeth into the position shown. I also want to call to your attention that it is possible to get amalgam models of any type of malocclusion and that any change in the three planes in which we are able to move teeth, is shown.

Fig. 17 shows the occlusal right, left and front views of a case which resembles a distoclusion case with linguo version of maxillary anterior teeth. I

will go through the different steps which are used in predetermining the tooth movement.

The first thing noted is the difference in the size of the two arches and the excessive overbite, also the drifting forward of the maxillary deciduous molars and first permanent molars, due to the early loss of the right maxil-

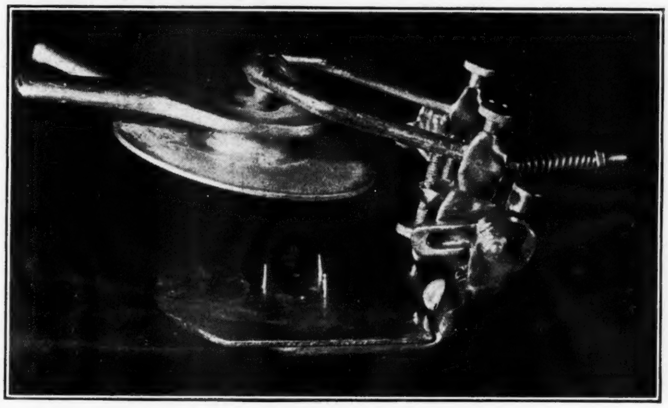


Fig. 14.

Fig. 15.

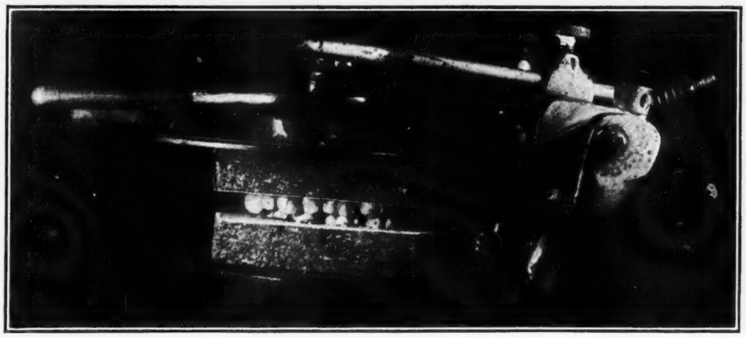


Fig. 16.

lary deciduous first molar and the breaking down of the left maxillary first deciduous molar.

Why is the maxillary arch less crowded than the mandibular? It is due to the excessive overbite. So I open the bite to an average overbite which gives me almost enough room to correct the irregularity in the mandibular

arch. Since the maxillary arch is already crowded, I correct the alignment of the six anterior maxillary teeth. I then widen the mandibular arch until I have them in normal alignment. When I have done this, I find the mandibular first molars have come forward about one-sixteenth of an inch, due to the widening of the canine and deciduous molar region. I now move the

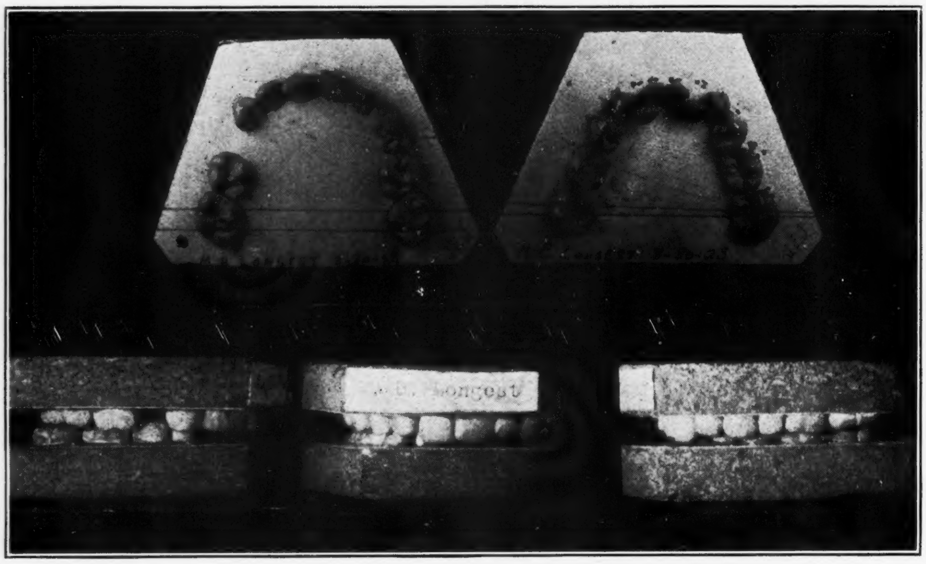


Fig. 17.

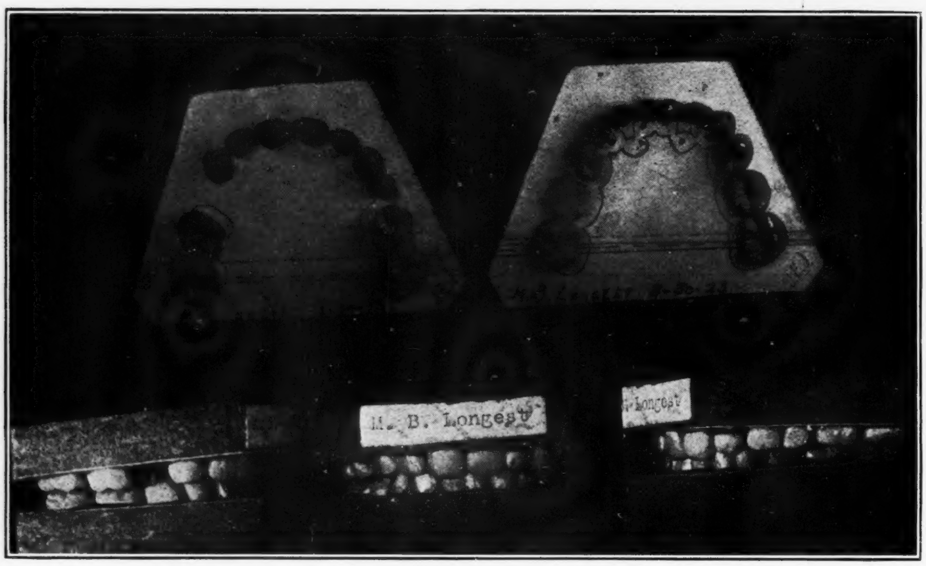


Fig. 18.

maxillary second deciduous and first permanent molars back until they occlude in a normal, mesiodistal relation with the mandibular molar and I find this regains the space of the first deciduous molars which have been lost. (Fig. 18.)

Fig. 19 is a neutroclusion, or Class I case. The front view shows that either the maxillary or mandibular median line is off. By means of the appli-

ance in Fig. 3, I am able to determine that the maxillary median line was correct. So in correcting the malocclusion, the mandibular arch was shifted to the left. (Fig. 20.)

Figs. 21, 22, 23, and 24 show before and after treatment of two cases of distoclusion. In this type of case, I find that I can gain considerable space if

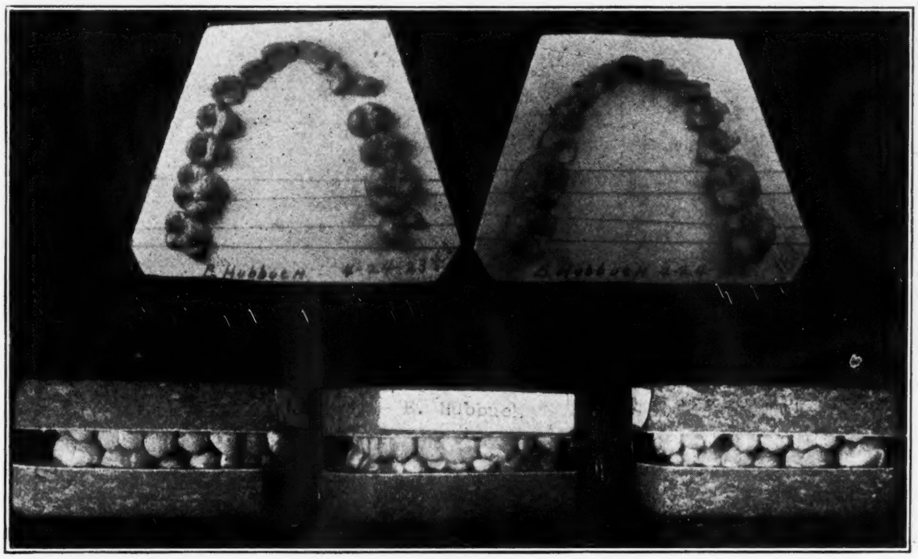


Fig. 19.

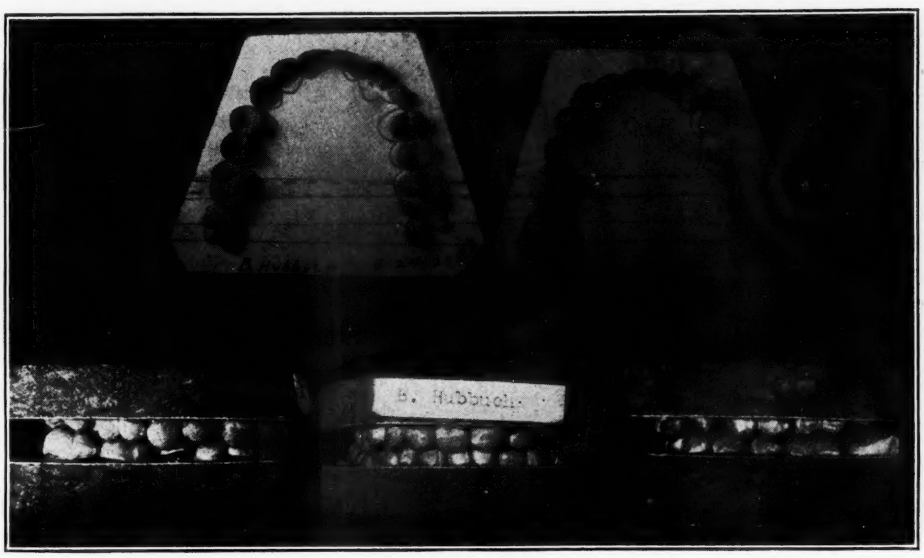


Fig. 20.

I rotate the maxillary molars outward and the mandibular inward. In each of the cases, the arches were widened, the maxillary anterior teeth were retracted and the mandibulars drawn forward. Due to the excessive overbite, it was found necessary to elevate the mandibular molars and premolars. When this condition is bad, it is necessary to elevate the molars and premolars in both jaws in order to retain the curve of Spee.

Figs. 25 and 26 show a bad case of distoclusion of a child not quite seven years of age. I present this case to show the amount of tooth movement necessary to correct it. The width of the maxillary and mandibular laterals was judged by Black's table of averages for these teeth.

Fig. 21.

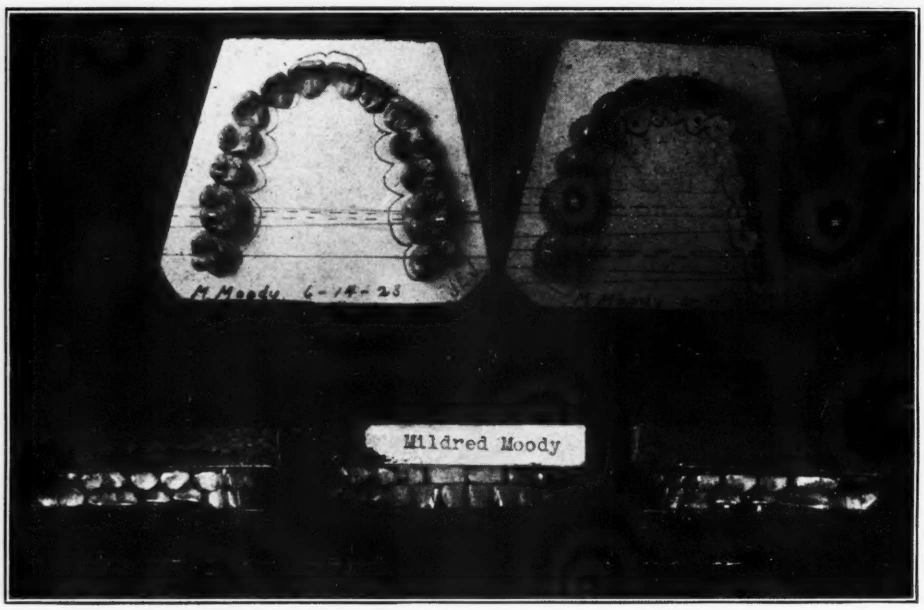


Fig. 22.

Before closing I wish to emphasize the following points in the method I have shown you.

1. The time necessary to predetermine a case, which may be summarized as follows:

	Minutes
Taking impression, bite and finding median line	20
Grating down impressions	5
Mixing and packing amalgam	35
Trimming amalgam models and tracing teeth on mat	25
Total	85

Fig. 23.

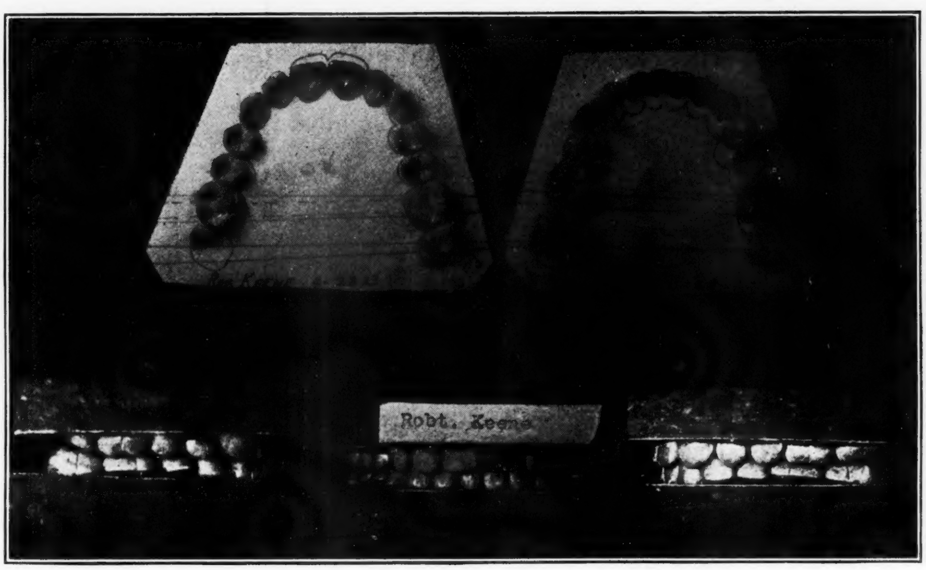


Fig. 24.

In other words, it takes one hour and twenty-five minutes actual working time to get models in the articulator, ready to predetermine the case. It will take fifteen minutes to an hour to move the teeth into normal occlusion, the time depending on the case.

2. The technic is very simple, the average assistant can do all the work

except the actual moving of the teeth. It really takes less skill and time to make the amalgam models than it does to make a plaster model from a plaster impression.

3. The cost is trivial, the amalgam being the principal item.

Fig. 25.

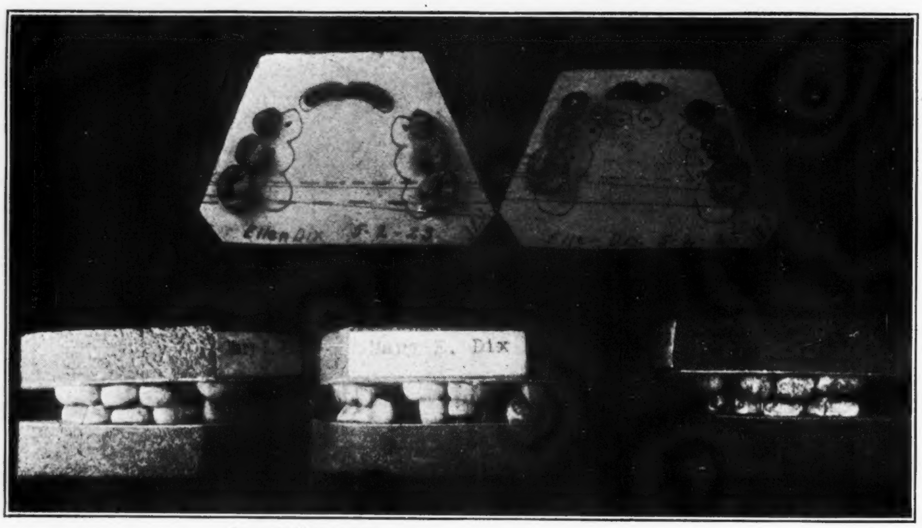


Fig. 26.

4. The amalgam models can be moved in the three planes in which a tooth can be moved; that is, forward or backward, in or out, up or down, or rotated, and these movements are shown and can be accurately measured.

5. The tooth movement in any denture can be predetermined, that is, a deciduous mixed or adult case can be moved into what we consider to be normal for that age.

FACIAL DEVELOPMENT*

By Professor Arthur Thomson†

I WISH, in the first instance, to express my appreciation of the compliment you have paid me by inviting me to address you on facial development. I gathered, from the reply of the secretary, that I was selected to speak on this particular subject because, by accident, I happen to be the professor of anatomy at the Royal Academy. I confess that I do not altogether see the connection. I am more interested in the subject from a scientific than from an esthetic point of view. It is rather to the scientific aspect of the question that I wish to direct my remarks, particularly to that side of the subject which is now usually described as mechanistic, but which I, for my part, would prefer to regard as the reaction of structure to function. Of course, any attempt to deal in detail with the subject would involve a much longer time than is at my disposal, yet, for the sake of the development of the argument, it is necessary that I should draw your attention to certain matters with which you are doubtless already well acquainted. In dealing with this question, I am afraid some of my opinions may appear unorthodox. However, I am prepared to submit them to the test of your critical faculties, knowing full well that there is no society more competent than your own to deal with my arguments. The more one goes into the question the more one realizes that it always resolves itself ultimately into the question of teeth.

I will first direct your attention to the mesial longitudinal sections of three skulls, Fig. 1, the first that of a man, the second a chimpanzee and the third a gorilla. The figure represents the skulls oriented on a common base of the *same length,* corresponding to the craniofacial axis disposed at an angle of 27° to the horizontal. My reason for drawing your attention to these sections is because it is necessary to have some common standard of comparison between the types with which we have to deal. We may take the craniofacial axis as marking off the two parts of the skull, viz., that which is cerebral, from that which is facial. If we can find a common meeting ground on this craniofacial axis, then, it seems to me, there is reason for drawing a comparison between the different types based upon such a common base line. With respect to man, I would suggest that, as between individuals and races, it is most important that we should have a plane of common comparison, such a plane as may be oriented in a particular way, and then we will be able to realize what grows out above and behind it, and what grows down below and in front of it, or, in other words, what it owes to cerebral expansion on the one hand, and facial protrusion on the other. A distinguished Dutch professor of the eighteenth century, Peter Camper by name, first drew attention

*Read before the British Society for the Study of Orthodontics.

†Dr. Lee's Professor of Anatomy, University of Oxford.

to this matter, and utilized the craniofacial axis as the base line of comparison. There have been numerous other attempts to orient the human skull on a common base line, but these are, if I may say so, artificial and not morphologic. As a result of many experiments I have come to the conclusion that, if this craniofacial axis be disposed in relation to the horizontal plane at an angle of 27°, then we have, so far as it affects man, a morphologic ground of comparison. In the gorilla and in the orang, you will note how the muzzle or facial part of the skull preponderates in size over the cerebral envelope. In man, on the other hand, you will find an enormous development

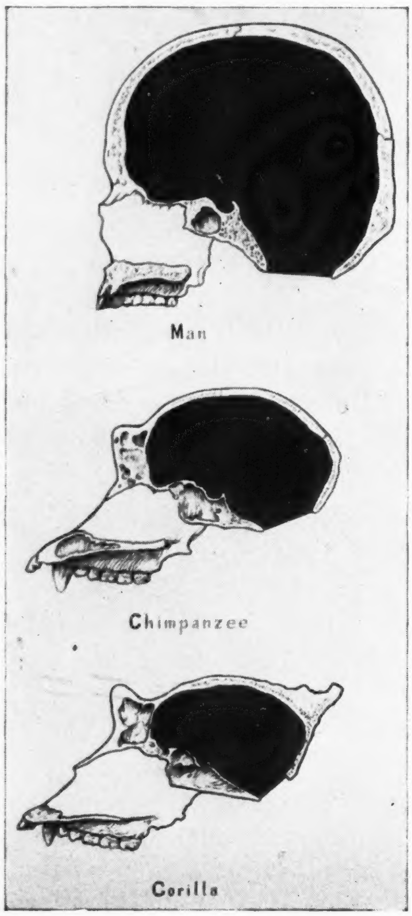


Fig. 1.—Mesial longitudinal sections of the skulls of a man, a chimpanzee and a gorilla, oriented on a craniofacial axis of the *same length*, disposed at an angle of 27° to the horizontal. The diagram illustrates the *relative* proportions of the facial and cranial parts of the skulls when reduced to a common base line of the same length.

of the brain case and a reduction in the size of the facial skeleton, the facial triangle denoted by the lines associated with the name of the late Sir William Flower, who was the first to point out the enormous importance of the size of the teeth, in respect of the varieties of mankind. He made use of the teeth to group mankind into the big-toothed variety, the middle-sized toothed variety, and the small-toothed variety.

In my next illustration (Fig. 2), in which the method of orienting the craniofacial axis at an angle of 27° with the horizontal has been adopted,

we have the outline of three skulls superposed. The three types represented comprise a British, an Australian and a Negro (Malay) skull. You will see how varied the form and development of each of them is. In one, the British, the form is determined by the brain at the expense of the face. In the Australian, the muzzle is large and the calvaria small. In the negro, there is a well-developed muzzle associated with a brain case of fair average capacity. I am assuming that you are familiar with all these facts, but it is necessary for me just to point out their connection with what I have presently to say.

Taking now another skull (Fig. 3-*A*)—a medieval British skull, you will see that the teeth are all present except the last maxillary molars. Note particularly in this instance the area of attachment of the temporal muscle. The next illustration (Fig. 3-*B*) exhibits an Australian skull with much larger teeth and a heavier mandible. Obviously, to move such a jaw, a much more powerfully developed temporal muscle was required, consequently the

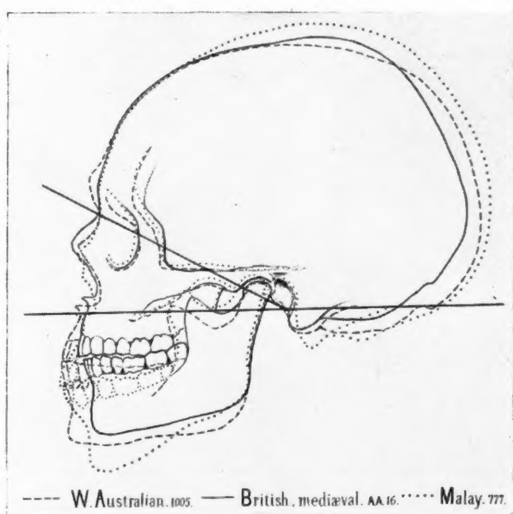


Fig. 2.—The outlines of a British, an Australian and a Negroid skull superposed on a craniofacial axis of the same length, disposed at an angle of 27° to the horizontal. Note the relative size of the teeth and mandibles.

area of attachment of the muscle, as displayed on the skull, is much greater in this case than in the medieval specimen. Further investigation proves that, as a general rule, the bigger the teeth, and the heavier the jaw, the more pronounced will be the development of the temporal muscle, whereas in people with smaller teeth, the musculature of the mandible will be less powerfully developed.

In the next illustration (Fig. 4) fifteen mandibles are shown, all of which at the time of death, had their full complement of teeth. You will notice that these jaws have been placed in a somewhat unusual position. In most of the textbooks the mandible is usually represented as placed with the lower border of the body or horizontal ramus in a horizontal position, and the posterior edge of the ascending ramus is allowed, so to speak, to select its own slope. My reason for orienting the inferior maxilla in the way indi-

cated in the diagram, is to show, as you will see presently, that the posterior edge of the ascending ramus is more constant in position than is the lower border of the horizontal ramus, for the former more nearly approaches the vertical than does the latter the horizontal. You will be struck by the differences displayed in these various mandibles. There is a cast of the mandible of the most ancient fossil man yet known, the Mauer or Heidelberg jaw. Note its massive construction and very broad and low ascending ramus. This series of illustrations has been arranged so as to show the varying width of the ascending ramus. You will notice that it gradually becomes narrower in the process of evolution from the lower to the more civilized type. But this collection of jaws also reveals the fact that the ascending ramus in the series is becoming more elongated. A further point is that whilst in the oldest jaw of which we have any knowledge, the coronoid process is low and stunted, as we pass upwards in the series this process exhibits considerable variation

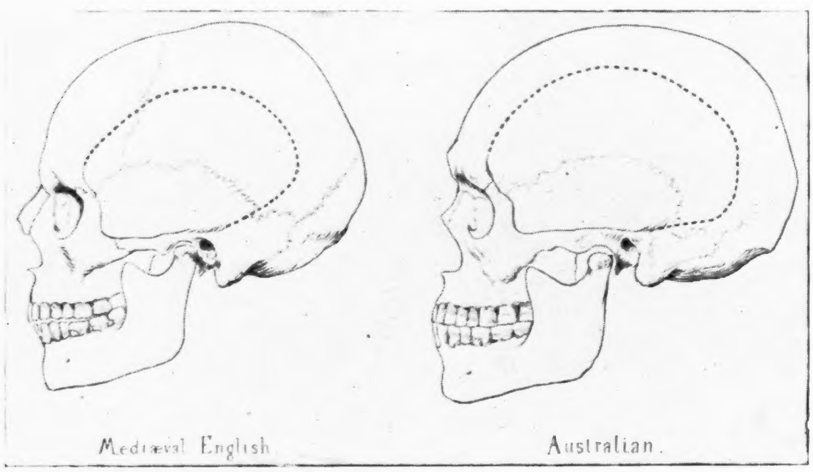


Fig. 3.—Diagram illustrating how the Australian skull with the bigger teeth and more powerful mandible exhibits a larger area for the origin of the temporal muscle (represented by the dotted outline) than is displayed by the British skull, which has smaller teeth and a less strongly developed mandible. The examples chosen are average and not extreme types.

in respect of its height or length. In this connection I may be permitted to remind you of certain facts with regard to the methods which nature adopts in the application and production of force generated by a muscle. If two muscles be taken, each having the same number of fibers, the longer the fibers are, the slower will be the contraction of the muscle, and the more powerful its action. If the muscle fibers be shortened, the muscle acts more quickly, and that increase in speed is gained at a sacrifice of power. Nature, in the case of temporal muscle, adapts the muscle to the immediate requirements of the case. In the big-toothed varieties of man, where the food is coarse and rough and requires a powerful apparatus to chew it, we recognize the advantage of a low coronoid and a broad ascending ramus, the former associated with a lengthening of the fibers of the temporal muscle, whilst the latter affords the benefit of increased lever action. As you ascend the scale, and the teeth are reduced in size, probably as the result of artificial means

of softening the food, such as by cooking, you get the ramus narrower and the coronoid process more pointed.

These variations in the length of the different parts of the jaw result in differences in the splay of the angle. Viewed from the standpoint of the teaching laid down in the textbooks, there is considerable confusion in respect to this matter. It is constantly asserted that the angle opens with advancing years, and too little emphasis is laid on the fact that the changes are largely induced by the shedding of the teeth. In this instance, however,

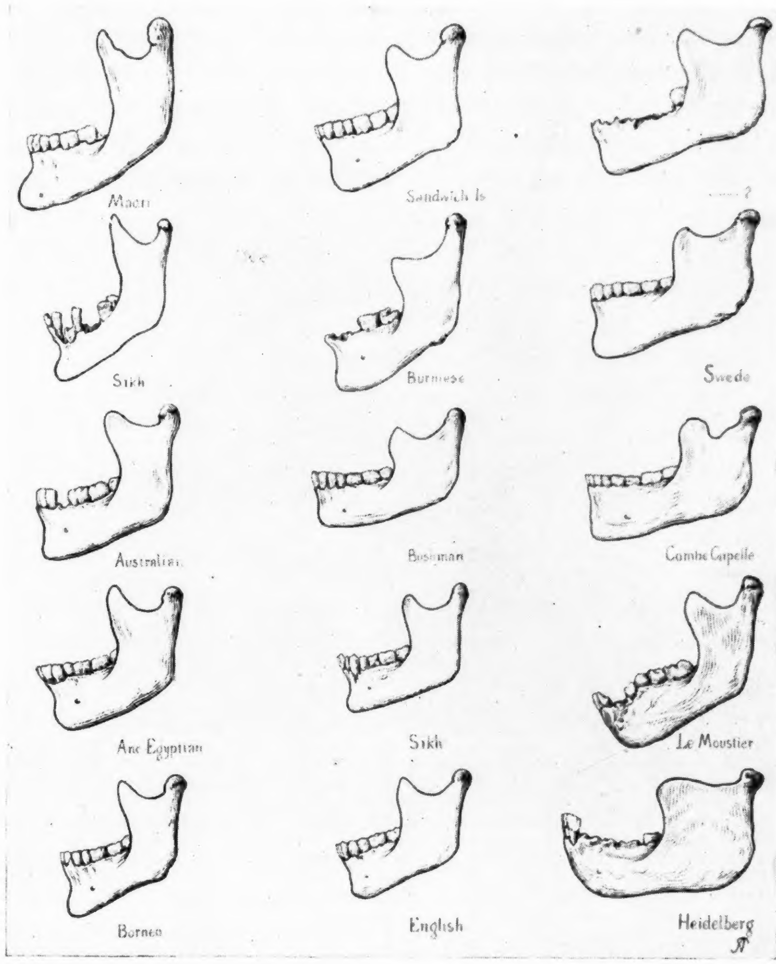


Fig. 4.—The figure illustrates the variety of form displayed by the human mandible. The specimens selected possessed, at the time of death, most if not all their teeth. Note the varying breadth and height of the ascending ramus, the upstanding nature of the coronoid process in some instances, and the varying splay of the gonial angle. The specimens are represented in what is assumed to be their normal position when the skull is oriented with the craniofacial axis disposed at an angle of 27° to the horizontal. (See Fig. 5.)

I want you to notice, that in all these specimens, the teeth are either all present, or were all present at the time of death, and yet you see there is a remarkable variation in the appearance of the angle of the mandible. I would value the assistance of those of you who are immediately associated with the practice of dentistry in the elucidation of one interesting point. Supposing that a man or woman,, in his prime—say from twenty-five to

thirty years of age—is provided with a complete denture, both upper and lower, it would be extremely interesting to know what changes take place in the angle of the jaw by the time they reach the age of seventy, making due allowance, of course, for the absorption of the alveolar border, and taking every possible care to avoid any sources of error.

I next show you (Fig. 5) a composite picture of the outlines of twenty skulls of various types and races, oriented on the common base line of the craniofacial axis. It is a remarkable thing, that the posterior borders of nearly all the ascending rami of the mandibles of these skulls, for the space of an inch or so, are disposed almost vertically in the same plane. I have not yet had an opportunity of analyzing these observations very carefully, but it is a striking fact that the lines of all these superposed mandibles, at this point—the back of the ramus—are almost identical. On the other hand, if we take the lower border of the horizontal ramus of the mandible, we

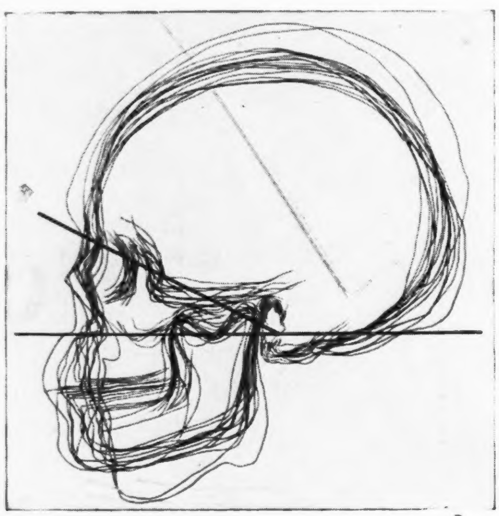


Fig. 5.—A composite figure composed of the outlines of 15 skulls oriented on the craniofacial axis disposed at an angle of 27° with the horizontal. In this instance note that the craniofacial length of each individual skull is represented. The angle between the two lines, viz., the craniofacial axis and the horizontal, closely approximating to the position of the basion, is taken as the fixed point. As will be seen, the outlines of the majority of the posterior borders of the ascending rami of the mandibles display a nearly vertical direction. The composite comprises the following skulls: African Negro, Roman, British, Negro, Chinese, Sandwich Islander, Zulu, Javanese, Maori, Dane, South Australian, Turk, Russian, Bushman, and Anglo-Saxon.

note a remarkable range of variation in its disposition. When one comes to think about this, one appreciates that there is a physiologic reason for it, because if we were to adjust these mandibles to a base line determined by the means and extremes of the positions occupied by the lower mandibular borders, we would have as a result a condition in which, in some instances, the mouth could not be opened.

I wish next to refer, for a moment, to the lengthening of the coronoid process, a condition necessarily associated with a shortening of the fibers of the temporal muscle. Here I must take the opportunity of directing your attention to the fact that in dealing with the senses, as related to facial development, we have to remember that the tongue, in which the sense of taste

is located, is also directly associated with movements of the mandible during mastication. I venture to think, however, that due consideration has not been given to the fact that, as we speak, the mandible is in a constant state of flicker, the movements being very slight and very rapid. A consideration of these facts led me to inquire further into the mechanism of the mandible, and I realized that a factor of such importance as the determination of the center of gravity of the jaw has been almost entirely overlooked. I have devised a piece of apparatus by which I am endeavoring to record the varying position of the center of gravity of the jaw, and so draw certain deductions, but unfortunately I have not had the time at my disposal to complete the record or to provide you with any particular results. But I want you to notice that by adopting the ordinary methods used to determine the center of gravity, I can place the jaw in a position of equipoise, and when it is thus balanced, you will find that the posterior border of the ascending ramus is almost in the same position as that indicated in the illustration I have just shown you. Ordinarily we are unconscious of the fact that some slight muscular effort is required to keep the jaws closed. It is only at death, or in unconsciousness, that the mandible drops, thereby indicating that the slightly heavier part lies in front of the center of gravity, which is usually situated at the middle of a transverse line passing through the interval between the first and second molar teeth. You will realize that if the mandible in nature be so balanced, the muscular effort necessary to produce the slight tremulous flickering movements which are associated with the enunciation of speech, while they entail but a very slight amount of muscular effort, do necessitate that such action should be rapid and prompt. I venture to suggest, therefore, that this development of the coronoid process, as displayed in different groups of mankind, is intimately associated with the elaboration of a more complicated system of speech. Whereas in fossil man, and possibly in the humbler types of mankind now existing, the great essential was power to crush the food, we, by the adoption of cooking, have been able to attain the same end with the expenditure of less power, whilst, as speech has been developed and become more complicated, the necessity for more rapid, if less powerful, action has become developed.*

There is another detail the importance of which I do not think has been sufficiently realized in this connection. Here again, you are familiar with the description given in the various textbooks of the movements of the mandible at the temporomaxillary articulation—a glide combined with a hinge movement. Great stress is laid upon the importance of this in diminishing strain of any sort on the inferior dental nerve as it passes into the inferior dental canal. That, no doubt, is one advantage, but there is another that has been overlooked. By the combined movements at the temporomaxillary joint, the coronoil process and the insertion of the temporal muscle are always kept in line with the direct pull of the muscle, to the direct advantage of the action of the muscle.

*Possibly the elongated and recurved coronoid process in the mandible of the Herbivora may be accounted for in much the same way, only here the action is concerned with the rapid movements involved in nibbling the pasture on which the animal feeds.

What I have said in respect to the temporal muscle and the lengthening or shortening of its fibers applies with equal force to the masseter muscle, but the time at my disposal is insufficient to enable me to enter into this aspect of the question. I would remind you of what is pointed out very clearly by Tomes, that there is an inverse ratio between the development of the temporal and the masseter muscles. Thus, in cases where the temporal muscle is great in bulk, the masseter is reduced in mass, whereas, when the temporal is small, a large masseter is met with.

Turning to another aspect of the subject, I would like to remind you of certain features in connection with the architecture of the superior maxilla. The two superior maxillae are united by a median suture. The arrangement of the hard palate and the alveolar borders is not unlike that of an apse; it will be noticed that the apse is buttressed up posteriorly and thus prevented from slipping backwards, by the outstanding processes which are familiar to you as the pterygoid processes of the sphenoid bone. It is these which prevent the backward thrust of the maxilla when subjected to blows from the front. These pterygoid processes may be described as forming the internal buttresses of the superior maxilla just as do the zygomatic arches externally. When we come to examine the pterygoid plates—and they, be it remembered, are developed in membrane—it is interesting to note that very remarkable differences are to be observed in the expansion of these processes in different individuals. My attention was first directed to this when examining a series of Eskimo skulls. In studying the effect of muscular action, one must always bear in mind the fact that a muscle having two attachments will exercise its traction effect on both its areas of attachment, at what we call its origin, as well as at its insertion, and under certain conditions, the action may be reversed. In nature we have many examples of the reversed action of a muscle, where the so-called origins and insertions may alternately react to the contraction of the muscle. In the Eskimo we have a very interesting demonstration of how the external pterygoid plate reacts to the strain imposed upon it by the action of the external pterygoid muscle. The Eskimoes have particularly large external pterygoid plates, which indicates that the external pterygoid muscles are powerfully developed. As a result, when you examine these processes with care you will notice that their relations to other parts of the cranial base are somewhat disturbed. Under ordinary circumstances, when you examine a skull in the *norma lateralis,* you cannot see the foramen ovale, which lies so horizontally that it escapes the eye. But in the majority of Eskimo skulls, when so examined, the foramen ovale is clearly visible. We can only account for this by assuming that the pterygoid muscles are so developed in this particular type of skull that they exercise a traction effect upon the surfaces of bone from which they arise, and pull them slightly outwards and downwards, so that the foramen ovale, in place of being horizontally disposed, as is usual, is oblique in position, and therefore is better seen. At the time I studied these skulls—a good many years ago—I was not in a position to offer any explanation of the condition, but subsequently it came to my knowledge that these people

habitually employ their leisure, if I can so describe it, in chewing the hides from which they make many of their domestic articles. Men and women, when they have nothing better to do in the long winter night, are constantly chewing and grinding these hides so as to soften them, and render them suitable for the purposes for which they are intended. This is borne out by the particular conformation of the temporomandibular joint, and also by the way in which the teeth are ground down. Into this subject Sir Francis Knowles, then my assistant, made an inquiry which I suggested to him, and in his paper he dealt with the peculiarities met with in the joint surfaces. It is to this expansion of the external pterygoid plate that I now wish to draw your attention, as proving how such a muscle as the external pterygoid, whilst causing a movement of the mandible on the one hand, may on the other react on the form of the cranial bones from which it derives its origin.

In the arrangement of its parts the superior maxilla is a wonderful bone. The thinness of its walls is quite unusual, and yet it resists the pressure to which it is subjected in a manner quite astonishing.

The antrum is one of its features about which we know very little except perhaps the obvious suggestion that its presence helps to lighten the bone. We do know that, in man, the antrum appears to have, as Sir Arthur Keith has shown, an intimate association with the eruption of the molar teeth of the maxilla. I venture to suggest that possibly the molar teeth have more to do with the expansion of the antrum than the antrum has to do with the eruption of the molar teeth. It may be that the truth lies between the two. But my reason for taking up so definite a position is, that when you view the subject from a wider standpoint, you will find that the molar teeth are just as well erupted when there is no antrum at all. Perhaps the instance in which this is most apparent is in the baboon. You can convince yourselves by the inspection of the specimen which I have brought that in that ape there is no antral cavity so called, and yet that there is a general resemblance in the architecture in the face of this beast to that of man. It seems to me that one is, with equal logic, justified in saying that the activity of the dental germ is in itself sufficient justification for the expansion of the antrum. As regards any function that the antrum may have, there has always been a difficulty. We have had to rest content with the suggestion that it is intimately associated in some way with phonation. If it be necessary to provide the antrum with some function other than that of merely lightening the bulk of the bone, I would almost be inclined to suggest that possibly it acted as an air space which it utilized as an efficient nonconductor. This would prove of service in maintaining the temperature of the blood circulating in the mucous membrane overlying the nasal conchae, an arrangement which I have elsewhere referred to in connection with the function of the nose as a heating apparatus to raise the temperature of the external air before it reaches the lungs (see *Journal of the Anthropological Institute*, vol. liii, 1923). The most important point to consider, as it seems to me, in regard to the architecture of the maxilla, is to think of the inner and outer walls of the antrum, the inner wall being the nasal wall, and the outer the facial wall. It must

be through one or other of these walls that the pressure exercised by the teeth when powerfully opposed, must be transmitted. Either one or the other, or both, of these walls, supporting as they do the alveolar border on which the teeth are set, must bear the pressure thrown on them, and obviously the pressure will vary according as the teeth are set in relation to one or other of these walls.

The next consideration is the matter of the muzzle. Again referring to the morphologic baseline, the craniofacial axis, we have the brain-containing part of the skull above and behind, and the muzzle in front and below. Now I ask you to examine a few typical mammals and see what happens. Take, for example, the dog (Fig. 6) or the pig, or the horse (Fig. 7). You will notice the small provision for the brain behind the craniofacial axis, and the great expansion of the muzzle in front of that line. I want you to look particularly at the position of the orbit. The orbit lies behind the muzzle, and the orbital margins are incomplete posteriorly, except in the case of the horse, of which mention will be made hereafter.

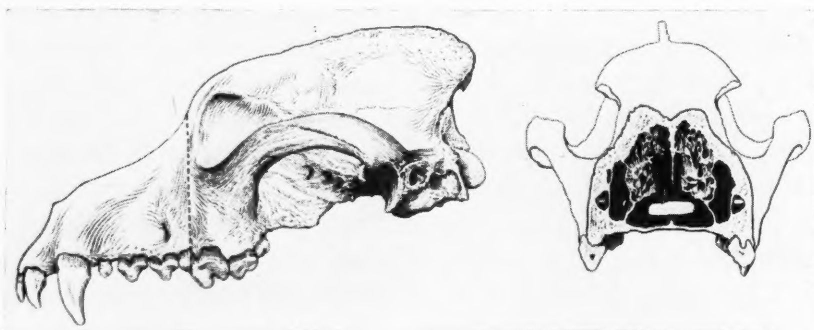


Fig. 6.—Drawing of the skull of a dog, showing by means of the dotted line where the muzzle at its stoutest part has been sectioned. The outline to the right exhibits the appearance displayed in the cut surface of the cranial half of the skull.

If you take such a skull as that of the pig, you will notice that as the brain increases in size, so the orbit comes forward and acquires a higher position. I show you another example in the case of the baboon (Fig. 8), where there is still a good-sized muzzle, associated with a bigger brain case, and the orbit has now risen to occupy a position above the muzzle. Note what this change involves. It brings about an alteration in the relation of the posterior orbital circumference, which has now become an external orbital margin. The more this change in position takes place, the more complete becomes the external orbital margin, until, as in the baboon and the orang, the orbital cavity is completely cut off from the temporal fossa, conditions apparently associated with a reduction in the size of the muzzle and an increase in the capacity of the cranial cavity. In man, with the further reduction in the muzzle and the great increase in the size of the cranial cavity, the external margin of the orbit becomes extremely well developed. What is the reason for this? It is best explained by further reference to the skull. In the lower forms, the canines are enormously developed; apart from the consideration of the general reduction in the size of the teeth in man, the

most important factor is the small relative size of the canines. Let me remind you that these are hooking, holding, and lacerating teeth. Disposed as they are, near the extremity of the mandibular lever, they can exercise but a relatively slight crushing pressure. The arrangement of their roots confirms this view. On the other hand, you will notice, if you take the skull of a dog and look at it carefully, that the maxilla is most stoutly and strongly developed opposite the carnassial tooth (Fig. 6). It is at that point that the construction of the bone is best fitted to bear the crushing pressure. You will notice that the strongest part of the maxilla lies in front of the orbit, and that the posterior orbital wall and margin is deficient, whereas in man its comparable part, the *external orbital margin,* is stoutly developed. You will find, if you examine a series of mammalian skulls, that, with the reduction in the size of the muzzle, the strongest part of the maxilla gets closer to the orbit, and that the orbital aperture becomes directed more forward than outward, and that its margins, in place of being anterior and posterior in position, now come to lie internally and externally in relation to each other. Finally, you find that, when the canines have become small

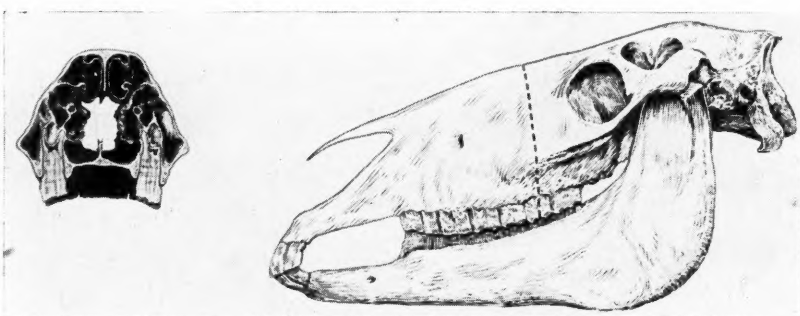


Fig. 7.—Drawing of the skull of a horse. The dotted line indicates where the section was made. This was selected because the bones of the muzzle here seemed stoutest. The figure to the left represents the appearance of the cut surface of the muzzle end of the skull.

and unimportant, and have been dispensed with as weapons of offence and defence, the main force of the bite having been shunted on to the molars, the strongest part of the jaw, which will naturally have to resist the crushing strain, will fall in line with what we term the external orbital margin, which is, morphologically, the same margin as, in the dog, we call the posterior orbital circumference. In the dog's skull you will see there is no posterior orbital wall (Fig. 6). If a transverse section of a dog's skull be made passing through the carnassial tooth on either side (Fig. 6), it is here that the structure of the maxilla will exhibit its stoutest development. You will notice that here the arrangement of the bones of the muzzle has a resemblance to a Gothic arch, of which the pillars correspond to the alveolar border in which the teeth are set, the summit of the arch being formed of the stout and thick nasal bones. As will be seen in the section, the bones within the arch are feebly developed. The hard palate forms a tie which prevents the spread of the arch, the whole serving as an admirable arrangement to withstand the pressure transmitted through the teeth.

In the horse (Fig. 7), the orbit is not formed in the same way as in the dog. It has a complete bony circumference, formed, as Flower points out, in an unusual way, by the union of the external orbital process of the frontal with the squamosal part of the temporal and *not with the malar*. This is an arrangement made, no doubt, to afford additional strength to the attachment of the massive masseter muscle. In this case, also, the coronoid process of the mandible is elongated and recurved whilst the temporal muscle is small, and consists of short fibers, an arrangement which supports the view I expressed earlier in the lecture, that in this case we have a muscle well adapted to furnish the rapid movements involved in nibbling grass.

The strongest part of the maxillae lies in front of the orbit. When viewed in section, the enormous teeth are seen set in between the inner and outer walls of the antral space and not in correspondence with the outer wall as shown in the dog, so that the pressure is in part distributed through the inner as well as the outer walls of the body of the maxilla, a circumstance which accounts for the greater thickness of the bony partitions occupying the

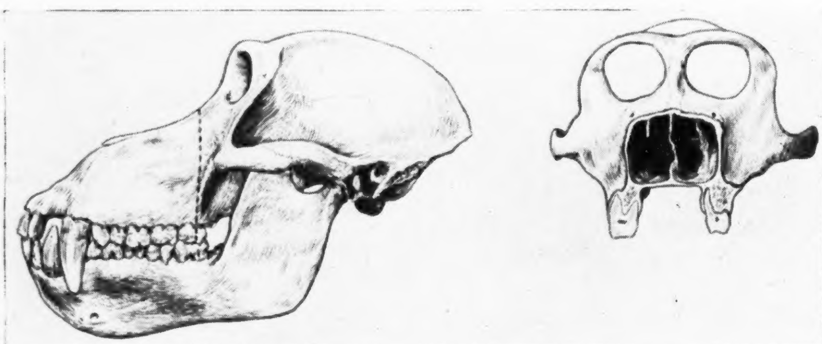


Fig. 8.—Drawing of the skull of a baboon, showing line of section (dotted). To the right is seen the appearance of the cut surface of the cranial half of the skull.

interior of the muzzle. There is also an ingenious arrangement whereby the canal which transmits the infraorbital nerve serves as a tie to unite the other parts of the bone, and thus provides a remarkably strong framework, which, though delicate in structure, is obviously well designed to withstand pressure. In the baboon (Fig. 8), there is no antral cavity at all. In place of it, there is a thin and wide flange of bone which materially strengthens the osseous structure. In section, the teeth are seen lying just below the outer wall of the maxilla, which is here reinforced by the thin flange of bone above referred to. In the orang (Fig. 9) the size of the muzzle is somewhat reduced by the forward expansion of the cranial cavity above and behind. In this case, the strongest part of the maxilla corresponds to the spring of the pyramidal eminence, which, in man, we call the zygomatic process. It is this part of the bone which forms the buttress on which the malar or zygomatic bone rests. The lower edge of the zygomatic process may be referred to as the zygomatic crest of the maxilla, and in this instance it will be seen to fall in line with the interval between the first and second molar teeth. If a vertical transverse section be made through the maxilla in this plane, the stoutness of the

bone along the line of the outer wall of the body of the maxilla will be observed, and a considerable thickening of the inner antral wall will also be noticed. The stout outer wall of the maxilla becomes continuous, above, with the compact tissue of the malar bone, through which the pressure is conducted along the outer orbital wall to the supraorbital margins, which are here strongly reinforced and united to each other in the middle line by the dense bone underlying the glabellar region—which bone, be it noted, extends down between the orbital cavities where it blends below with the inner antral walls, here more than usually stout. I wish especially to direct your attention to this arrangement, for, as you know from experience, one of the commonest mistakes the beginner makes in handling human skulls is to lift them by inserting the thumb and forefinger into the orbital cavities. The results of this procedure are apt to be disastrous, for in man the bones which occupy the interorbital interval are so thin and delicate that they are apt to be crushed and broken. Not so in the case of the apes, for there the lachrymals and ethmoid are much more stoutly developed, and will resist very consid-

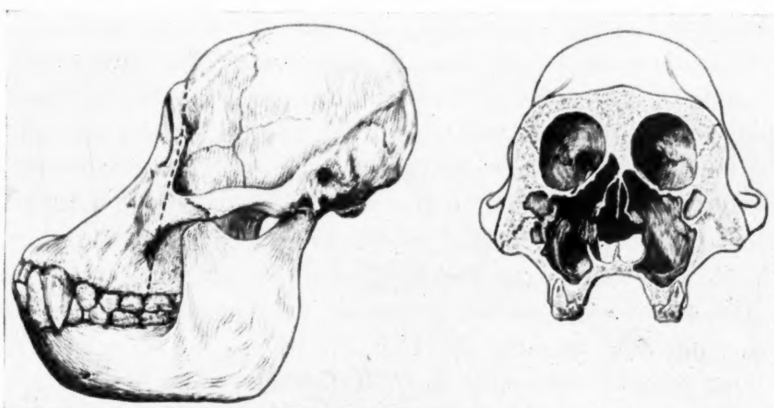


Fig. 9.—Drawing of the skull of an orang, showing dotted line of section; to the right is seen the appearance of the cut surface of the cranial half of the skull.

erable pressure when applied to them. This all seems to point to the conclusion that in the apes the inner antral walls, and the bones which occupy the interorbital interval, bear a part in resisting the pressure to which this part of the face is subjected when the teeth are forcibly used.

In comparing a vertical transverse section of the facial skeleton in man (Fig. 10), made in much the same plane, certain noticeable differences will be remarked as compared with the appearances displayed in the orang. The line of stoutest bone will be traced from the alveolar border along the outer antral wall to the malar or zygomatic bone, through which it passes to be continuous with the stout external orbital margin, whence it passes to the external angular processes of the frontal. But here a difference is at once observed, for in place of the pronounced and compact supraorbital margins displayed in the orang, the conditions are altered by the forward bulge of the greatly expanded cerebral envelope, whereby the frontal squama now occupies a more vertical position, and is in consequence better fitted to withstand a vertical pressure than when, owing to the existence of a lesser

cranial capacity, it occupied a more sloping position. In the latter case it had obviously to be reinforced at the supraorbital margins to withstand the upward thrust. In the illustration given, where the cranial capacity is large, the frontal squama, now nearly vertically disposed, absorbs much of the pressure.

In the higher races of man, owing to the relief given in this way to the upper orbital margins, to enable them to withstand the pressure to which they are subjected, we find a complete absence of a supraorbital torus. It is only in the more lowly forms, where the cerebral development is small, and in consequence the frontal squama more oblique in position, that we recognize the massing of bone in this situation as necessary. This observation is borne out by the appearance displayed by the Australian and Neanderthal types, and further emphasized by the characteristic features exhibited by the anthropoid apes.

A further feature of interest which the section of the facial skeleton displays, is that the bones occupying the interorbital interval and limiting the extent of the nasal fossa are on the whole much weaker and not so stoutly developed as the corresponding bones in the apes. This may possibly be due to the fact that, owing to the altered condition and the greatly increased size of the cranial cavity, they are not now called upon to bear a share in resisting the upward pressure. We have already seen how closely face projection in man is associated with size of teeth. Other things being equal, we know that big-toothed races are prone to be prognathous, whilst small-toothed people exhibit the straightest faces. Naturally the size of the teeth will determine the point of greatest pressure, and consequently react on the structural arrangement to meet it. It is interesting to see what confirmation of this we meet with in our researches. Referring to the pyramidal zygomatic process of the maxilla of which the lower border, as I said, might be called the zygomatic crest, it is notworthy that its fusion with the body of the bone will vary in different individuals and races according to the size and arrangement of the teeth. The importance of this observation depends on the fact that it is through this crest that the main part of the pressure is transmitted upwards through the malar bone on to the external orbital margin. It is therefore of some interest to note the variations in respect of position of these osseous points, viz., (1) the zygomatic crest, and (2) the external orbital margin, to the molar teeth.

To my assistant, Miss Beatrice Blackwood, B.Sc., I am indebted for the following notes. In the 277 skulls examined, the zygomatic crest of the maxilla was situated, in descending order of frequency, between the first and second molars, over the second molar, or over the first molar. Certain interesting racial differences also became apparent. In prognathous skulls the zygomatic crest lies most frequently over the second molar with a bar of bone running obliquely down to the alveolar border over the first molar.

In the table which follows these have been counted as over the second molar. The change noted in modern English as compared with ancient British skulls is interesting.

TABLE I

SHOWING POSITION OF ZYGOMATIC CREST OF MAXILLA IN RELATION TO MOLAR TEETH

GROUP	OVER I MOLAR Actual No.	Per Cent	BETWEEN I AND II MOLAR Actual No.	Per Cent	OVER II MOLAR Actual No.	Per Cent
28 Negroes and Australians.....	3	10.7	9	32.1	16	57.1
45 Chinese	9	20.0	27	60.0	9	20.0
47 Eskimos	19	40.4	15	31.9	13	27.6
19 Indians (Calcutta)..........	9	47.4	6	31.6	4	21.0
53 Ancient British.............	27	50.9	12	22.6	14	26.4
14 Medieval English............	9	64.3	2	14.3	3	21.4
71 Modern English.............	10	14.1	25	35.2	36	50.7
277 Total number of skulls examined.	86	or 31.1%	96	or 34.7%	95	or 34.1%

The external orbital margin lies, in the majority of skulls examined, over the second molar tooth or between it and either the first or the third, but in certain cases it is found to be situated as far forward as the first molar, or as far back as the third. It lies, as a rule, slightly behind the zygomatic crest, but may, especially in Chinese skulls, be situated immediately above it. The analysis of the figures is shown in the Table II.

TABLE II

SHOWING POSITION OF EXTERNAL ORBITAL MARGIN IN RELATION TO MOLAR TEETH

GROUP	OVER I MOLAR No.	Per Cent	BETWEEN I AND II MOLAR No.	Per Cent	OVER II MOLAR No.	Per Cent	BETWEEN II AND III MOLAR No.	Per Cent	OVER III MOLAR No.	Per Cent
27 Negroes and Australians	3		3	11.1	16	59.3	8	29.6		
45 Chinese ...	5	11.1	11	24.4	23	51.1	6	13.3		
38 Ancient British			12	32.4	21	54.1	5	13.5		
14 Medieval English			7	50.0	6	42.9	1	7.1		
72 Modern English			9	12.5	32	44.4	25	34.7	6	8.3
196 Total No. skulls exam.	5	2.5	42	21.4	98	50.0	45	23.0	6	3.1

Referring again to the supraorbital region in man, it is clear that this is formed by the fusion of the supraorbital margins with that part of the frontal squama which overlies the frontal lobes of the brain. Morphologically, the frontal bone is in part a bone of the face as well as of the cranial vault, the position of the ophryon—a variable point corresponding to the center of the least transverse width between the frontal temporal crests—serves to indicate the line of separation between the two parts. Below it are situated the parts of the bone which enter into the composition of the face and which comprise the two superior orbital margins, whilst above it lies that part of the frontal squama which covers the anterior lobes of the cerebrum. The two together constitute what in man we term the forehead. The anthropoids, with the possible exception of the orang, have no forehead, for in them the

facial and cranial parts of the frontal bone are separated by a wide furrow which throws into relief the supraorbital arches and interrupts the surface continuity of these with the cranial part of the bone.

An examination of the mesial longitudinal sections of the skulls of the orang, gorilla and man (Fig. 1) will reveal how, by the gradual expansion of the cranial cavity, this apparent independence of the two parts is obliterated, so that, in man, there is little or no evidence to show their functional relationship. An examination of the crania of fossil man as well as the conditions displayed in the lowlier types of man now living, clearly prove that the evolutionary forces at work are mainly concerned with the expansion of the cranial envelope to accommodate a larger brain which, by its more or less complete fusion with that part of the frontal bone which is more intimately concerned in the construction of the face, leads to the production of those remarkable differences which are met with in the supraorbital region of the more primitive types of mankind. These differences, despite the views of

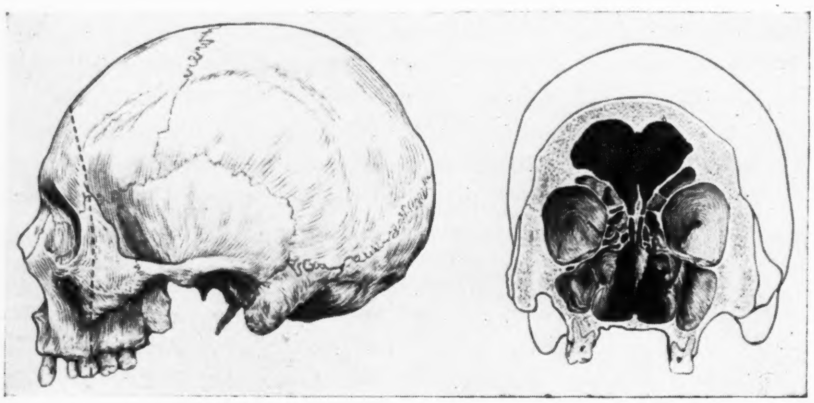


Fig. 10.—Drawing of a human skull, displaying the appearance of the section of the hinder half of the skull. The dotted line on the left hand figure indicates the line of section.

Schwalbe and others in respect of the characters of the Neanderthaloid crania, are not specific, but are merely stages in the evolutionary processes by which the higher and bigger-brained type has been evolved.

Some years ago I addressed myself to this problem and delivered an address at the International Medical Congress at Madrid wherein I endeavored to illustrate the process in a more or less experimental way. By many the results were considered more amusing than interesting. To be frank, I did not then realize their importance as I do now, for I had not then acquired such an insight into the arrangement of the facial skeleton as I now possess. Let me briefly recall the nature of the experiment. A skull was taken from which the sides and summit of the cranial cavity were removed leaving only the basal part, in other words that part of the calvaria which is developed in cartilage, in contradistinction to the bones of the sides and vertex which are developed in membrane. It is common knowledge that the latter, being much more plastic, are subject to the influence of pressure continuously applied during the active period of growth, as is proved by the resulting deformations

induced by the application of boards or bandages, practiced for esthetic reasons by some tribes of American Indians.

On the upper surface of the basal part of the skull, from which the sides and dome of the "skull cap" had been removed, an india rubber balloon was securely cemented, care being taken to allow the neck and orifice of the balloon to fall through the foramen magnum, so that the nozzle of a bicycle pump could easily be inserted into it, an arrangement which permitted the balloon to be easily inflated or deflated. The illustration given (Fig. 11) represents the specimen with the balloon distended in varying degree. It became at once apparent that by altering the amount of the distention of the balloon we could simulate the appearances displayed in the anthropoid apes, passing by successive stages to those characteristic of primitive man, and lastly exhibiting the conditions which we associate with modern man. These changes, being induced by the varying degrees of distention of the balloon, were in this respect comparable to the processes of nature, whereby an increase in the bulk of the brain leads to a necessary alteration in the expansion and form of the osseous cranial envelope.

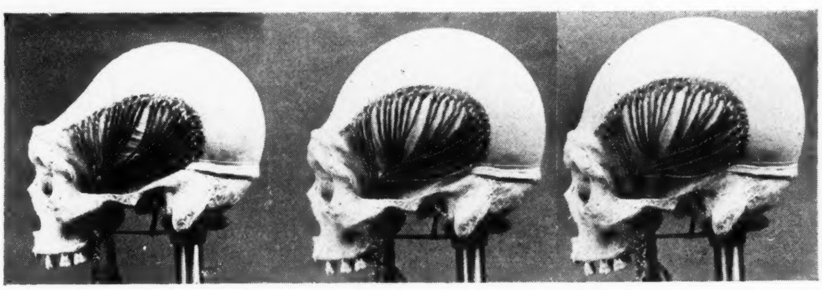


Fig. 11.—Photographs showing the appearances displayed when an india-rubber balloon cemented on the *same cranial base* is distended by varying degrees of inflation with air.

The results, so far as we are at present concerned, may be best realized by a glance at the accompanying illustration (Fig. 11) which is reproduced from the original paper. At the same time I would like to add that the other results obtained by this method were as remarkable, for it was clearly demonstrated that when a moderate amount of air was injected into the balloon cemented on to the same skull base, the form displayed by the specimen when viewed in the *norma verticalis* was of the dolichocephalic type, whereas when the amount of air was increased, in other words when the cranial capacity was made bigger—and that, be it noticed, on the same base length—the specimen assumed all the characters of a brachycephalic type of skull.

To return however to the matter in hand. The diagram (Fig. 12) I show you, exhibits, in outline form, three tracings of the same experimental skull. One of the outlines shows the form displayed when viewed in the *norma lateralis,* with the balloon but slightly inflated, the next exhibits the appearance when the balloon is moderately distended, the third and highest outline represents the shape of the head when the balloon is well filled. Each of these outlines may then be regarded as comparable to the change induced by an increase in the amount of cranial capacity.

Thus, taking the lowest of the three outlines, it will be observed that the ape-like characters of the frontal region are well represented, due, as here proved, to the feeble expansion of the cranial cavity. When this latter is increased, the isolation of the supraorbital part of the frontal bone from that part of the frontal squama which is more directly associated with the cranial cavity becomes less apparent, whilst when the cranial capacity is still further enlarged, the elevation of the frontal squama leads to its more com-

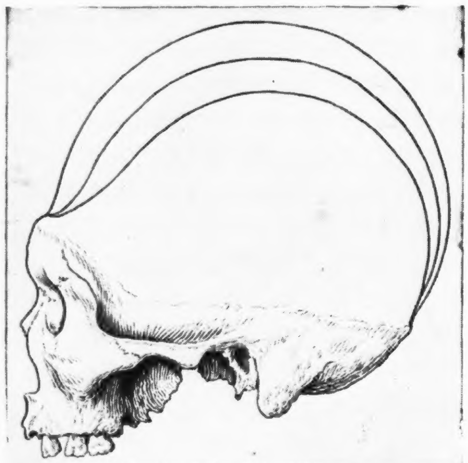


Fig. 12.—Diagram representing in three outlines on the same cranial base the contours displayed by the inflated balloon in different degrees of distension.

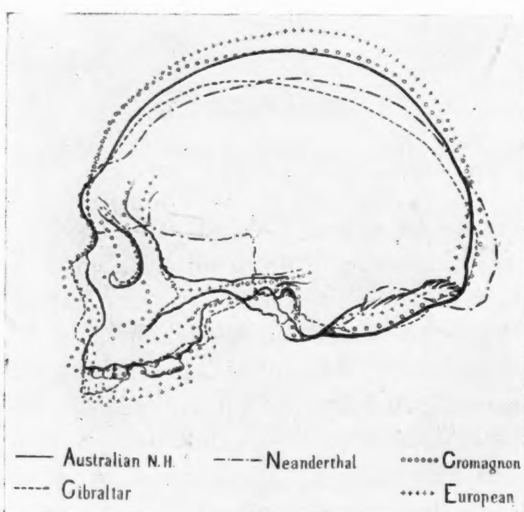


Fig. 13.—Diagram compounded of the outlines of the skulls enumerated, oriented on a craniofacial axis of the *same length,* disposed at an angle of 27° with the horizontal.

plete confluence with the supraorbital portion of the bone, thus producing the forehead which is so characteristic of the higher types of mankind. To enable you to realize the significance of these changes, let me ask you to compare with Fig. 12, a diagram (Fig. 13) compounded of the outlines of some living and some fossil types of man, noting for the time being that only these examples of fossil man have been included in which it has been possible to estimate the position of the craniofacial axis.

To me it seems that the comparison of the outlines of the two figures (Fig. 12 and Fig. 13) in the frontal region are so striking, that we are left with no alternative but to accept the view that the form of the lower frontal region in man is determined by the interaction of cranial expansion on the one hand, combined with the necessity of providing adequate resistance to withstand the pressure which, as has been already explained, is transmitted in man through the external angular processes of the frontal bone to the supraorbital arches. It is with some degree of confidence that I leave the consideration of this question to your impartial judgment.

MALOCCLUSION OF THE TEETH REGARDED AS A PROBLEM IN CONNECTION WITH THE APICAL BASE*

By Axel F. Lundström, Stockholm, Sweden

(Continued from July.)

II. Pathological Anatomy.

The influence of internal secretions on the development of the organism as a whole and of its parts having once been demonstrated, it was natural that dental authors should be led to attribute malocclusions of the teeth to endocrine disturbances. Disorders of growth in general accompanied by retarded dentition had according to Gilford[26]† been noticed as early as 1881, and Josefson[40] demonstrated that a disorder of development, one of the symptoms of which might be evident in retarded dentition, was caused by hypothyroidism, and succeeded by means of administering gland preparations in accelerating the eruption of the permanent teeth in these cases. Basing their opinions on the reports of Josefson, orthodontic writers began to interpret certain varieties of malocclusion as disorders of growth, and suggested that the mechanical treatment should be supplemented by organotherapy. This has been suggested by Grieves.[28] He states that a form of malocclusion occurring in connection with an enlarged tongue and mandible has been corrected by means of endocrine action without the aid of mechanical appliances. Regarding the prospects of correcting malposed teeth by such methods another author, Franke,[25] has advanced the following opinion: "the question whether it would be possible as a prophylactic or therapeutic measure successfully to administer gland preparation to stimulate the growth in cases of hypoplastic deformation of the jaws must be left to future decision on account of the position of this as yet very young science." About the same may be said of the prospects of success by means of dietetics, in spite of the remarkable results in artificially producing malocclusions that have been attained by Mellanby[59] and Howe.[37] This being the case we must at present resign ourselves and determine the nature of the different cases from observations of the most usual development of the different types of malocclusion. Data as to how these different types react to different kinds of treatment may be expected to give rise to rules as to the best methods of treatment. The differentiating principle for the malocclusions must consequently be the possibilities of correcting the malpositions and not the changes in position we may wish to effect. The possibilities of changing the positions of the teeth are limited by anatomical conditions, and the denominations of the different classes should preferably be anatomical terms. Such classifications as those of Angle, Case, Lischer and Simon take into consideration what their originators consider ought to be done. They

*Reprinted from Svensk Tandläkare Tidskrift, 1923.
†References will be published at end of article in last installment.

are based not so much upon organic characteristics as upon the position of the teeth in relation to a certain ideal position.

If the etiology of the different malocclusions and methods of neutralizing the causes were known, a classification of the cases of malocclusion could be conceived. This is possible only in exceptional cases and we have no other choice than to classify them according to their different external characteristics, thereby running the great risk of making mistakes. The early zoologists attached far too much importance to external resemblance, and Rhinoceros was considered as nearly related to Elephas. Increased knowledge of Palaeontology proved that its relationship was considerably closer to Equus. Regarding the classification of malocclusions the case has been very similar. In the diagnosis far too much stress has been laid on the temporarily perceptible deviations from normal occlusion.

How important it is to consider the origin of malocclusion in diagnosing a case, has been emphasized by Lourie,[54] who pointed out that failure to notice a local mesial movement of molars could be the cause of incorrect treatment. This idea was further developed and systematized by Grünberg,[6] who recommended what he called a "Rekonstruktion" of a case before attempting to decide to which class it belonged. He demonstrated that through ignoring the development or the history of the case mistakes might occur during treatment.

The diagnosis cannot be decided from the status presens alone. But this very mistake has been made by many authors who have worked out classifications. If the development of the case has been duly considered, which in many instances is possible by aid of comparisons, and if we use a terminology with terms that are explanatory in this respect we shall gain a better idea of the nature of the case and the prognosis for different modes of treatment in much the same manner as with help of Palaeontology and Comparative Anatomy we are able to get a better understanding of the relationship of different genera of animals than had been possible after an examination restricted to the anatomy of recent species.

As has been previously mentioned, our widened knowledge concerning the irregularities of the teeth has materially changed our ideas of their causes from what seemed to have been settled only a few years ago. But although our knowledge has increased it has been chiefly in demonstrating that our information on this subject is not so great as we imagined. The investigations of Cryer and Franke have proved the incorrectness of the once almost universal and still very widespread theory of mouth-breathing as always causing malocclusions and further, such dissimilar anomalies as mesio- and distoclusion.

Our knowledge of the causes of malocclusion being more limited than it appeared to be, when diagnosing a case we must content ourselves with observing the distinguishing traits of the anomaly and comparing them with similar anomalies, the abnormal development of which has been definitely recorded, whether or not they have been subjected to orthodontic treatment. After having collected a considerable number of data we shall be in a position to give an opinion on the desirability of a treatment or the prognosis thereof.

The discovery was soon made, that the classes of Angle contained anomalies of a very divergent nature, which caused a reaction against his classification. Objections were made chiefly against his Class I, which included cases showing a far greater affinity to Class II, Division 1, than to the majority of their own class.

Figs. 7, 8, 9, 11, 12 represent cases of what, according to the original Angle classification, would be termed Class I, that is to say, the first molars are in correct mesiodistal occlusal relation. Fig. 7 is characterized by a frontal bimaxillary crowding, Fig. 8 a frontal and sagittal crowding of the upper arch, Fig. 11 a labioversion of the upper incisors; in Fig. 12 the first upper and lower molars have drifted in an anterior direction, maintaining a

Fig. 7.

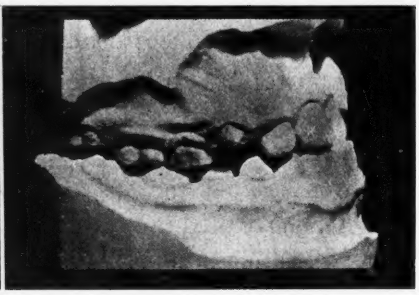


Fig. 8.

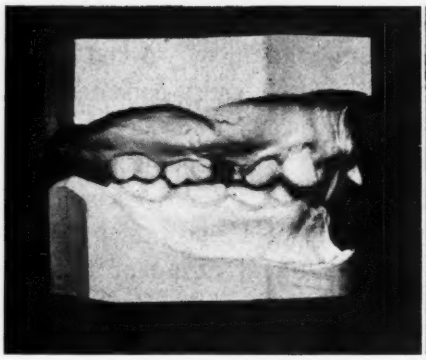


Fig. 9.

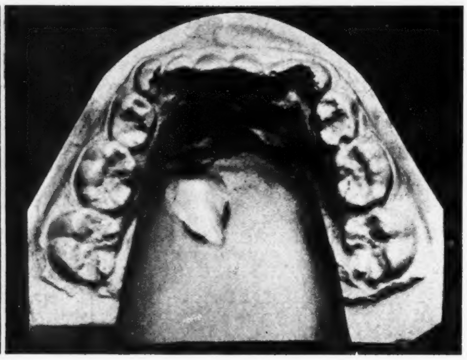


Fig. 10.

correct mesiodistal occlusion, the frontal and sagittal width of the arch being in other respects normal.

The term "Class I" gives us information on only one single detail, leaving us in ignorance concerning the type in general. As a brief descriptive term for the character of a case of malocclusion I have suggested the term momenta of malocclusion for certain characteristic anomalies.[55] The cases reproduced in Figs. 7 to 12 represent pure types. In Fig. 7, we find the momentum bimaxillary contraction; in Fig. 8, opistognathism, etc., but combinations of several momenta are very common.

1. The Different Momenta of Malocclusion

The occlusal-functional theory having been found to be not universally acceptable, it is necessary to make allowance for this fact when working out

the nomenclature, and as the causes of the malocclusions in a large number of cases are unknown, some other differentiating principle must be established.

According to Talbot[83] it is suggested in the Anatomy of Helkiah Crookes, published in 1618, that general constitutional factors are the causes of irregularities of the teeth. The tendency to ascribe them to such causes became more and more obvious, and authors like Sigmond (1825) and Mortimer (1836) assert that there are two groups of causes, natural and accidental; Guilford (1898): hereditary and acquired; Colyer (1900): general and local; Talbot himself had in 1891 classified the causes as constitutional and local. As late as 1922 Herbst* divided the causes into primary and secondary.

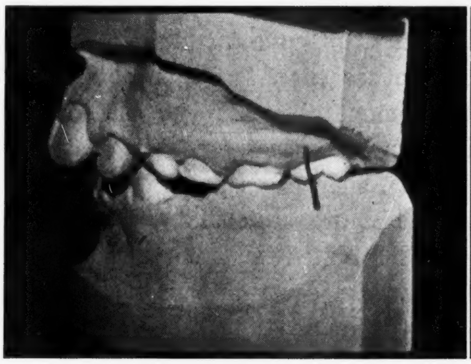


Fig. 11.

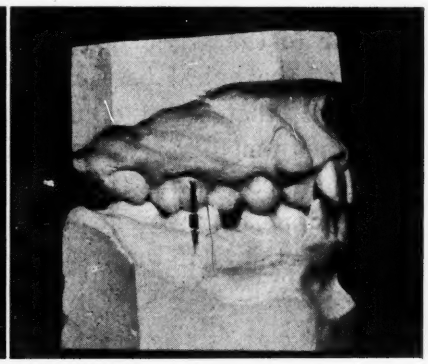


Fig. 12.

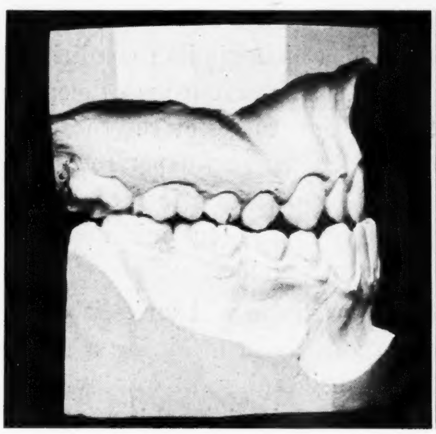


Fig. 13.

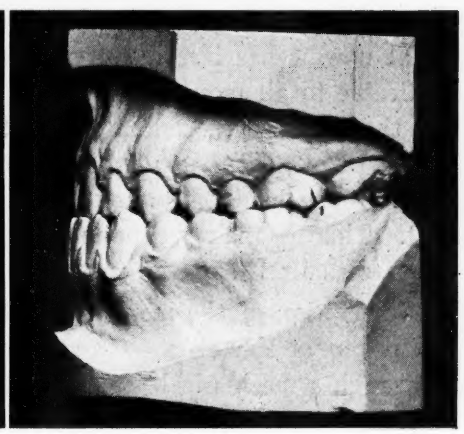


Fig. 14.

With reference to the momenta of malocclusion we may be justified in classifying them in a similar manner in two divisions. The first of these contains momenta that have pure local-dental causes; in the second are grouped together all the others. It seems probable that the momenta belonging to the second group are caused by very heterogeneous causes, and these are unknown. In contradistinction to malocclusions that are the results of local-dental causes and can be prevented and corrected to normal occlusion by dento-mechanical methods alone, provided the operator has an opportunity to select the most suitable time for treatment, cases that are the result of other than local-dental causes

*Herbert, E.: Atlas und Grundriss der zahnärztlichen Orthopädie. Münich, 1922.

behave in a radically different manner towards the same kind of treatment, and the chances of being able to attain a permanent normal occlusion are dependent on other factors.

The distinguishing feature of the latter group is this. The malocclusion is a result of an abnormal development of the apical base, which is not caused by any dental factor. We will call this group momenta of malocclusion caused by an abnormal development of the apical base. It is, however, of importance to bear in mind that disorders of development of the apical base may also be caused by local dental factors, as for example when teeth have been lost under certain circumstances, and also that arrest of growth from these causes may become an obstacle to the orthodontic attainment of a normal occlusion superficially similar to the arrest of growth that is often a result of an abnormal development of the apical base caused by other than local-dental factors. In spite of the fact that arrest of the development of the apical base caused by missing teeth may modify the result of an orthodontic treatment in a way similar to what may occur with the other group, such cases are still grouped with the local-dental momenta of malocclusion, because a normal occlusion can be attained with certainty if the treatment is instigated before it is too late. According as a case, in which dental factors would cause an arrest of the apical base development if allowed to exert their influence unchecked, is taken care of at an early stage, in the same degree will the result of the treatment approximate to normal occlusion, and provided this be the case, the treatment will be a purely technical problem.

Up till now it has been a very common idea that similar conditions have been applicable to all momenta of malocclusion. The erroneous conception has prevailed that if only the operator is in a position to select the most suitable time for treatment, even such pronounced mesioclusions as experience has demonstrated it to be hopeless to try and correct by orthodontic means, could be prevented. This idea, first expounded by Angle[5], has been published by Bimstein[14] as late as 1921, as if its truth were unquestionable.

The description of the momenta of the apical base will make it clear, that in malocclusions of this class the prospects of success in attaining a normal occlusion through a mechanical treatment vary considerably, at whatever age this treatment is performed, and this can only be explained in this way, that the size and form of the apical base are determined by conditions that are active, independent of the position of the teeth. The malocclusions that are caused by dental momenta may be corrected by dental and orthodontic methods alone, if a suitable age for treatment is chosen; but such a treatment, at whatever age it may have been effected and with whatever degree of mechanical skill it may have been performed, will not ensure the attainment of normal occlusion in cases of malocclusion caused by disturbed development of the apical base, unless the cause of this disturbance has ceased to be active. The cause being unknown, the result of the treatment is uncertain.

The two classes of momenta of malocclusion thus differ in the manner of their causation, but not necessarily as regards the condition, into which a case of malocclusion that has undergone treatment finally settles, as this condition

may in both cases be normal occlusion. But in the one it is the technically perfect treatment, performed at a suitable age, that is in itself sufficient, in the other, in addition to this, certain characteristics in the growth of the apical base, varying according to the nature of the momentum of malocclusion, are indispensable.

As regards the size and form of its apical base a dental arch may develop in two different ways. The apical curve may be in harmony with the coronal curve or the result of the development may be a disharmony. In the former case there is from the point of view of development nothing to prevent the occlusion being normal. Such disturbances are of many different varieties; they are seen as dislocations resulting from different forms of muscular pressure, but as most important in this connection we consider the early loss of temporary or permanent teeth and distoclusion.

The local-dental malpositions are due to factors that may be directly observed. Their development has occurred on an apical base that was at least originally normal.* In many cases the apical base retains its normal size and form in spite of the malpositions of the dental crowns. But the dental disturbances may occur at a critical stage of the development of the apical base, or are so extensive that the apical base itself is arrested in its development. This arrest of development is in contradistinction to that in the other group of a traumatic nature.

It is consequently of vital importance for the correct diagnosis of a case and for estimating the prognosis for the different methods of treatment to be able to decide whether a given case of malocclusion is caused by local disorders of the apical base. As it is often impossible to get reliable data concerning the history of such a case, the diagnosis will prove difficult and even impossible. Besides, local-dental disturbances may be present in cases of malocclusion due to momenta of malocclusion of the apical base. This subject will be easier to understand if the student is in a position to examine cases characterized by only one momentum of malocclusion. To get an idea of the local-dental momenta he is advised first to select cases with a normal apical base. When Grünberg wished to illustrate his method of "Rekonstruktion" he selected cases with assymetrical dislocations. Having in this manner got an insight into the characteristics of the dislocations that follow from a loss of teeth, it is easier also to recognize them in cases where the dislocation is bilateral. A similar method is recommended for learning to diagnose a momentum of malocclusion.

The student is advised first of all to learn to recognize the local-dental momenta of malocclusion, as their effect on the denture and especially on the development of the apical base is not so radical. We, therefore, first select cases with a normal apical base. This selection is to some extent rendered easier on account of the fact that both the classes of momenta of malocclusion differ in this respect, that the abnormality is bilateral in the second class, the momenta of the apical base, whereas in the first class, the local-dental momenta, the abnor-

*Naturally, local-dental disturbances may also develop in cases with momenta of malocclusion of the apical base. To enable us clearly to accentuate the difference between the two groups it is necessary to disregard this and assume the existence of purely local-dental momenta of malocclusion.

mal condition may be restricted to one side, a result of it having the character of a local disorder.

Under the heading progenie shall in due course account be made for the result of a momentum of malocclusion belonging to the group of the disorders of the apical base. Angle's Class III has a subdivision with the characteristic mesial occlusion restricted to one side, while the head class, Class III, Division 1, is characterized by "mesial occlusion of both lateral halves of the dental arches" (see Ottofy, Standard Dental Dictionary, p. 382). By mesioclusion is

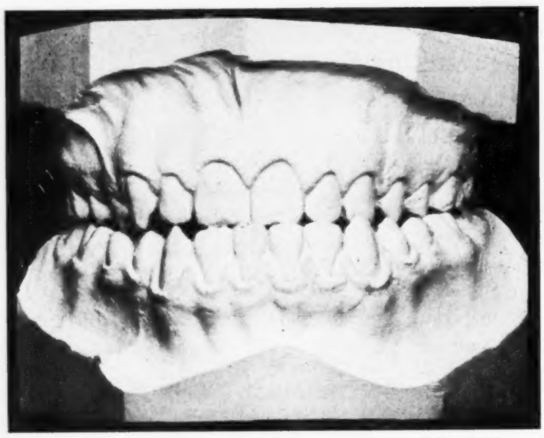


Fig. 15.

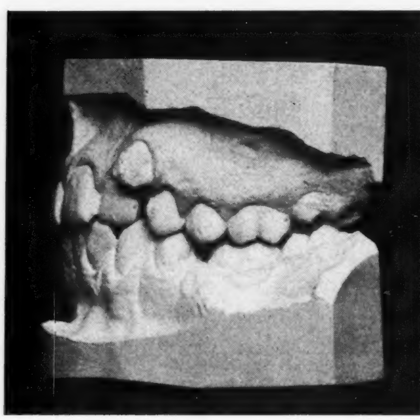


Fig. 16.

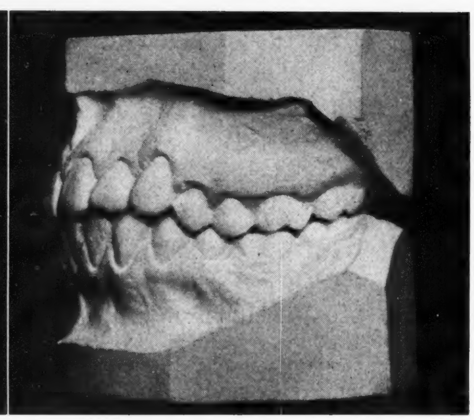


Fig. 17.

meant "a malocclusion characterized by a mesial or anterior relation of the mandibular dental arch to the maxillary dental arch." Another term is anteroclusion.[64] It seems doubtful if a disorder of growth of the variety that causes mesioclusion can be active unilaterally. Fig. 13 is a case having the right lateral half of the lower arch in mesial occlusion. As is seen in Fig. 14 the mesial occlusion is limited to the right side. The case belongs to Angle's "Class III, Subdivision," but it would not be correct to register it as a specimen of the disorder of the apical base classed as progenie, the relation of the apical and coronal curves being harmonious in each dental arch, and as a consequence the momentum of malocclusion is local-dental. It would seem probable

that this malocclusion has originated through a habit of occluding the lower jaw too far towards the left (Fig. 15). In all my thirty cases of Angle's Class III, in which the apical curve of the lower arch was abnormally large, a common feature of the progressive types of progenie, the mesioclusion was bilateral. If we strictly adhere to the definition of the term we may also conceive a local-dental type of mesioclusion, that has been caused with an individual with a normal apical base having the habit of closing the lower jaw symmetrically in an abnormal mesial position. Probably such cases have been observed, and if so we would have two different kinds of mesioclusion, one basal and one dental.

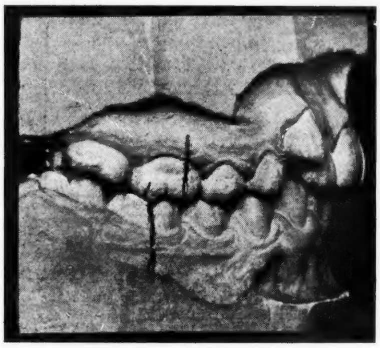


Fig. 18.

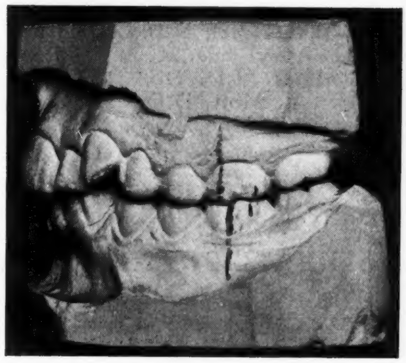


Fig. 19.

If the apical curve is in harmony with the coronal curve with the exception of some minor section of one or both of the dental arches the momenta of malocclusion of the case must be considered as local-dental. Fig. 16 illustrates a case of normal occlusion and normal apical bases in the right half of the denture. The malocclusion, confined as it is to the left side, is consequently due to some local cause. In the case shown in Figs. 18 and 19 the apical bases are normal, as are also the positions of the teeth of the lower arch and the incisors of the upper arch. The abnormal occlusion of the upper cuspids, premolars and molars is caused by a local disturbance.

(To be continued.)

DEPARTMENT OF

ORAL SURGERY, ORAL PATHOLOGY AND SURGICAL ORTHODONTIA

A SYSTEMATIZED TECHNIC FOR THE REMOVAL OF IMPACTED MAXILLARY CANINES

BY LEO WINTER, D.D.S., NEW YORK CITY

Clinical Professor of Oral Surgery and Diseases of the Mouth, New York University College of Dentistry.

(Concluded from July.)

BILATERAL IMPACTION—EDENTULOUS MOUTH

(Classification No. 6)

These cases are best operated upon by way of the palate. The incision and technic of the operation are exactly the same as for the single impacted canine, palatal method. (Figs. 66, 67.)

UNUSUAL CASES

1. Impacted canines which lie buccally. Usually in this type of impaction the tooth will be found above the apices of the teeth in position and directly below the antrum. Great care should be taken in the removal of these teeth to avoid penetrating the antral cavity. A good procedure is to remove the bone covering the inferior border of the tooth and work upwards. (Figs. 68 to 72.)

2. Impacted canine, crown palatally, and apex so far buccally and encased in bone as to render its complete removal by way of the palate a dangerous procedure in so far as injuring the adjacent teeth is concerned. When this particular difficulty is encountered, it is best to remove as much of the tooth by way of the palate as is possible without causing injury to the adjacent teeth, or closing the palatal flap; and then opening from the buccal aspect to remove the apical portion. (Figs. 73, 74.)

3. Impacted canines involved in dentigerous cysts. It is best in these cases to make a palatal incision, the variety which involves the gingival margins in order to get good access to the area. (Figs. 75 to 80.)

4. Impacted canines situated palatally in the region of the first or second molar. It will be found that a semilunar incision, a quarter of an inch above

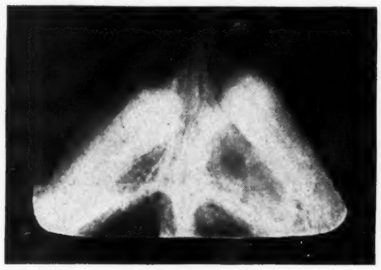


Fig. 66.—Bilateral impaction in edentulous mouth.

Fig. 67.—Bilateral impaction—edentulous mouth. These teeth are best removed palatally.

Fig. 68.

Figs. 68-72.—Types of impacted canines with crown portion palatally, which teeth however may be removed from the buccal aspect as well. This procedure is possible because of the absence of teeth in the adjacent areas. In removing these teeth from the buccal aspect, the root portion is exposed first, then by means of forceps the root is grasped, or an elevator is placed under the root portion and pressure is exerted outwards.

the approximate position of the crown of the impacted tooth will give excellent results. (Figs. 81 to 84.)

ILLUMINATION

The best illumination is obtained with the use of the Cameron Dental Lamp. Precaution should be taken so as not to overheat. Owing to the fact

that the palate is anesthetized the patient cannot feel the sensation of heat and the result of a burn may cause sloughing of the flap. To obviate the probability of such an occurrence the lamp should occasionally be immersed in distilled water to cool.

Fig. 69.

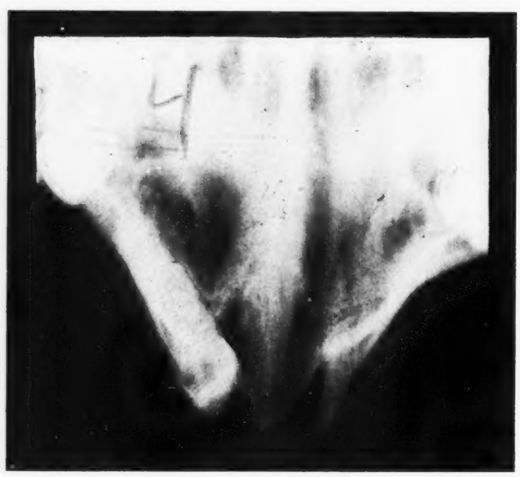


Fig. 70.

POSTOPERATIVE TREATMENT AND COMPLICATIONS

The postoperative treatment is symptomatic. Patients are advised to return the day following the operation and thereafter, at two- and three-day intervals. They should never be discharged until the wound has completely healed.

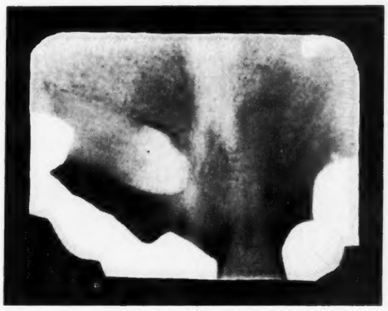


Fig. 71.

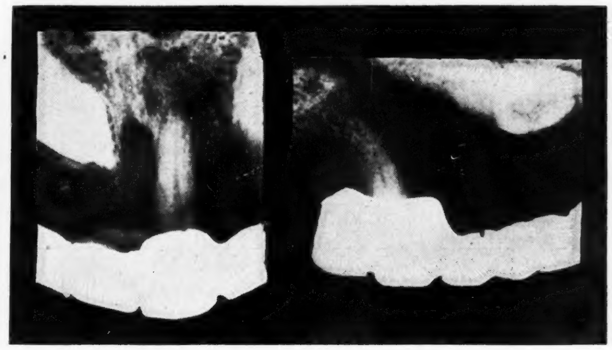


Fig. 72.

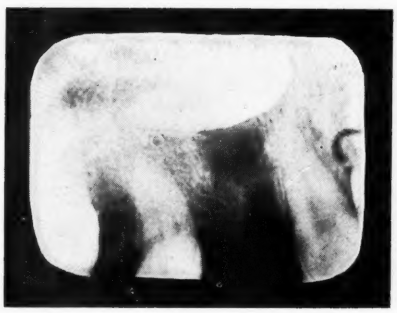


Fig. 73.—Radiogram of an impacted canine, which was removed from the buccal aspect.

Fig. 74.—Radiogram of a case referred to the author after an unsuccessful attempt had been made to remove an impacted canine palatally. It will be noticed that the apex of the lateral incisor has been injured, and the apex of the canine is still in position. The apex was removed with little difficulty from the buccal aspect.

POSTOPERATIVE COMPLICATIONS

(A) POSTOPERATIVE EDEMA

Postoperative edema, following the buccal operation, is generally reduced by the application of cold compresses for twenty minutes of each hour.

Swelling of the palatal mucosa, following the palatal operation, occurs in some cases. This condition returns to normalcy in from three to four days.

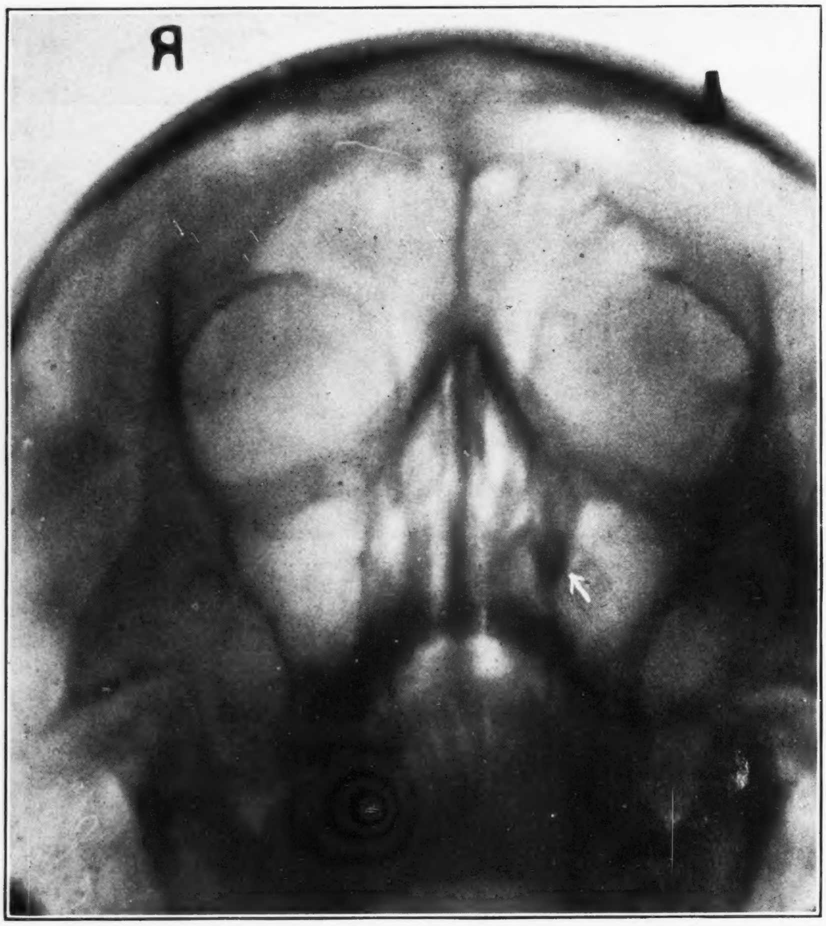


Fig. 75.—Case of a dentigerous cyst involving the antrum of Highmore, containing an impacted canine. This case was operated upon by way of the palate. Incision used was the one including the gingival margins of the teeth. The entire area was thoroughly cleaned out. Patient made an uneventful recovery.

In some instances, when the swelling has subsided, there may be a discharge of serum from an opening caused by lack of adhesion of tissues after the operation.

Daily irrigations with some mild antiseptic will bring about a healthy union in a few days.. In some cases, after the lapse of ten or twelve days there is a discharge of pus from the wound. This is usually evidence of a sequestrum. When these symptoms present themselves, the wound is reopened, the area curetted and all sharp edges of bone removed. The wound should then be irrigated every forty-eight hours until complete adhesion takes place.

(B) POSTOPERATIVE HEMORRHAGE

Excessive bleeding may not necessarily be caused by the rupturing of a vessel. Very frequently a persistent capillary oozing occurs which will cause the patient distress. Patients should be instructed to press a gauze packing against the palate and to hold the same in position by closing the jaws until

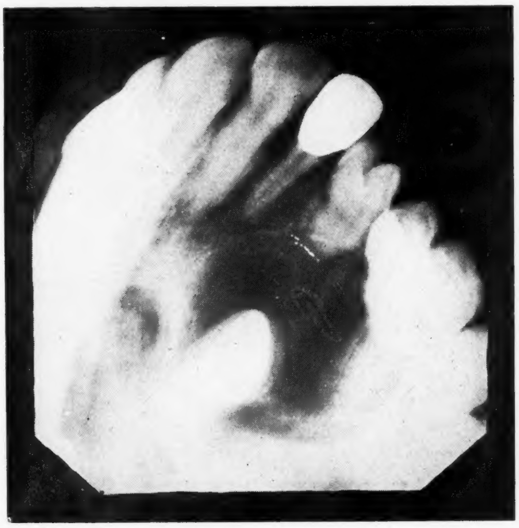


Fig. 76.

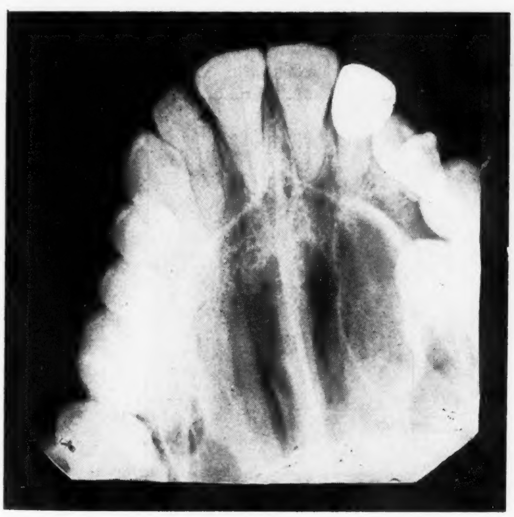


Fig. 77.

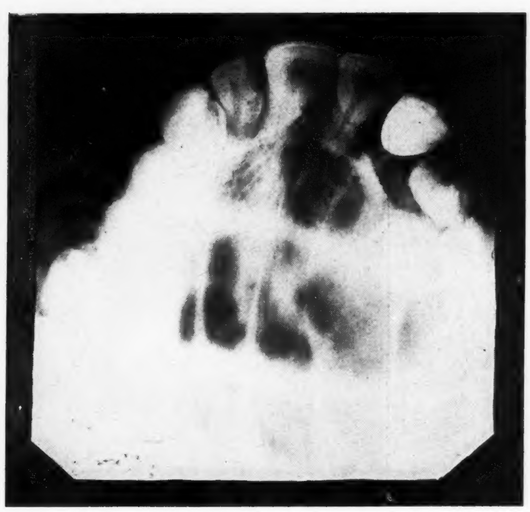


Fig. 78.

bleeding ceases. If hemorrhage continues they should seek professional aid. Caution patients to continue biting gauze until other aid is obtained.

An excellent method of controlling hemorrhage is the use of a strip of gauze, one inch in length, saturated with suprarenin solution 1/1000. Insert this into the wound between sutures. Pack and fill the wound over the suprarenin with borated or 5 per cent iodoform gauze strips for forty-eight hours. The gauze should not extend beyond the lips of the wound for two reasons, namely:

Fig. 79.

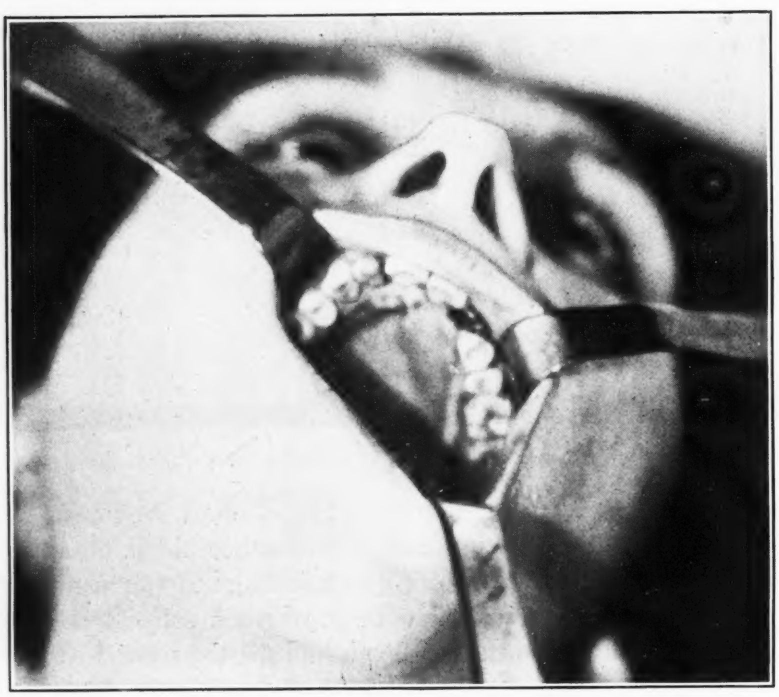


Fig. 80.—Two weeks after operation.

Fig. 81.

Fig. 82.

Fig. 83.

Figs. 81-83.—Impacted canines situated in the posterior portion of the palate. A semilunar incision from above downwards involving the area of the tooth will afford the best means of access.

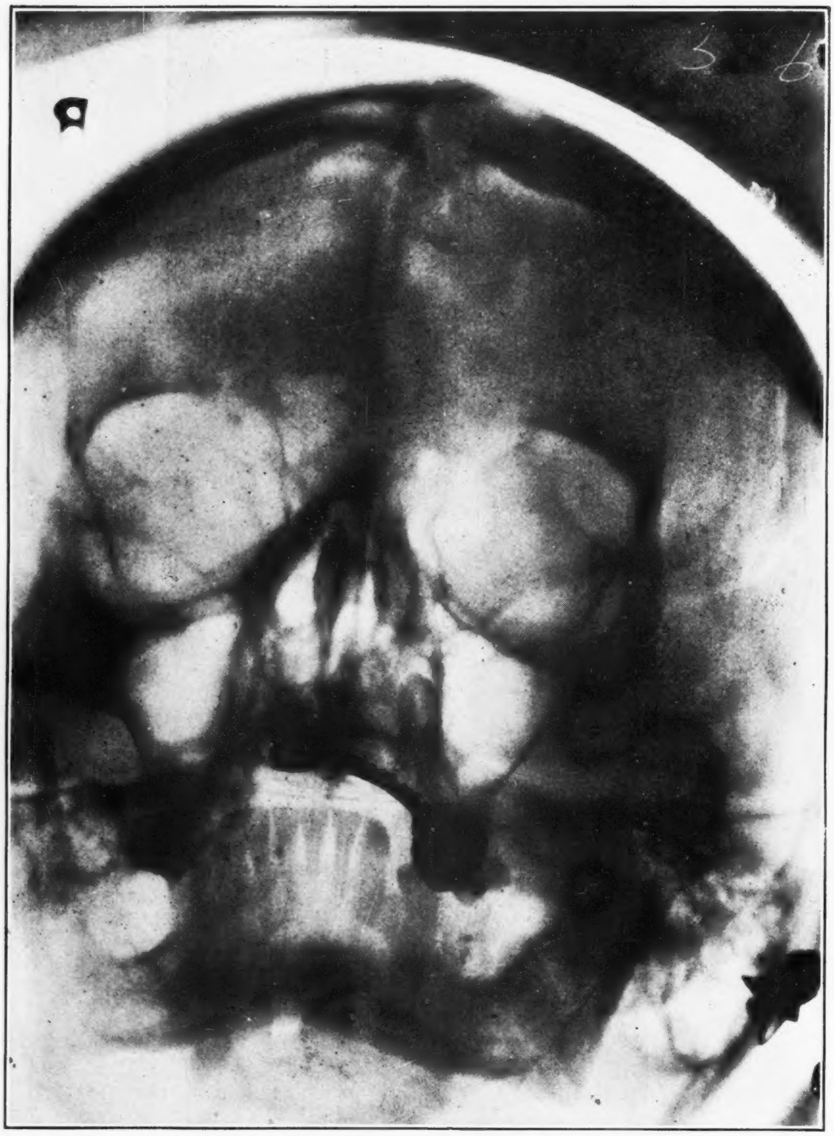


Fig. 84.—Impacted canine penetrating the nasal fossa. Tooth removed by means of the large palatal incision.

1. It may be loosened during mastication.
2. Gauze between lips of a wound may cause the mucous membrane to become smooth. This may prevent the natural process of healing.

(C) POSTOPERATIVE PAIN

Patients seldom complain of severe postoperative pain. As a preventive and corrective, pyramidon, one 5-grain tablet, taken every four hours, is recommended.

When the temporary inhibition of the conductivity of the sensory nerve endings has worn off and the normal sensation returns, I have found that the amount of postoperative pain bears no relation to the form of injection used.

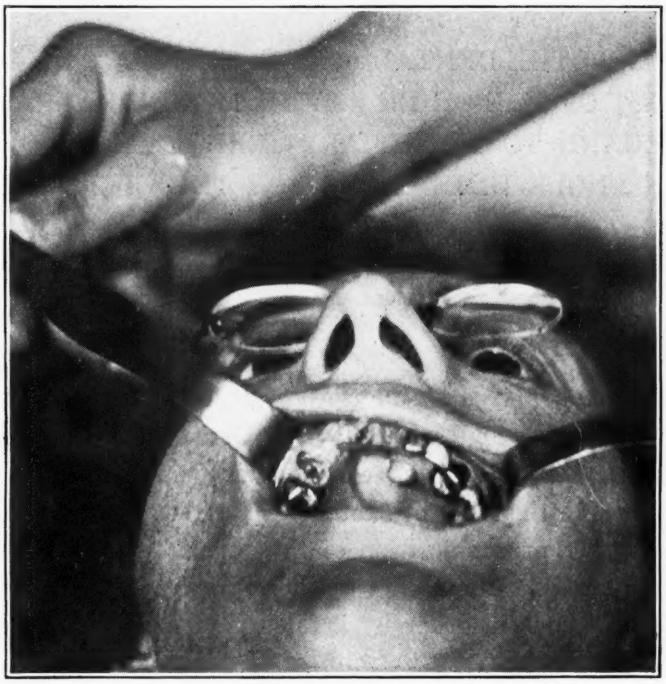


Fig. 85.—Impacted canine crown partially exposed. These teeth are best removed by making an incision beginning at the mesial surface, including the gingival margin to the distal surface, and extending the incision posteriorly for half an inch. The bone is then removed from the posterior surface of the impacted tooth and force then exerted in that direction. The flap should then be brought back. One suture will be sufficient. The attempt to remove a tooth of this nature with a pair of forceps without any other surgical interference usually results in breaking off the crown portion.

It is the same if the injection was made directly in the nerve terminals (terminal or infiltration anesthesia) or by acting on the nerve trunks supplying the site of operation, thereby interrupting the conduction of sensory impulses (regional or conduction anesthesia). It should be borne in mind that postoperative pain is caused by the trauma sustained in the operation and that the anesthetic agent plays no part excepting that its nerve-stilling effects are gradually lost and the true situation—pain from the operation—evidences itself. Therefore the more careful we are in the retraction of tissues and the cleaning up of all sharp edges and points following an operation, the more grateful our patient will be and he will show it in subsequent experiences.

DEPARTMENT OF
DENTAL AND ORAL RADIOGRAPHY

Edited By
Clarence O. Simpson, M.D., D.D.S., F.A.C.D.,
and Howard R. Raper, D.D.S., F.A.C.D.

THE POSITION OF THE DENTAL AXIS IN THE JAWS AND THE EXACT ADJUSTMENT OF THE CHIEF RAY IN THE INTRAORAL METHOD WITH REGARD TO MAXILLARY IRREGULARITIES. TABLE OF ANGLE DIMENSIONS FOR THE CHIEF RAY

By Prof. Dr. Med. A. Cieszynski, Lwow, Poland

I

In 1912, I published a treatise in the *Lwowski Tygodnik Lekarski* entitled "On the Intraoral Method as Applied to Dental Roentgenography,"† giving a simple method for directing exactly the principal ray by means of a table. It embraces, in the form of sketches, all the typical forms of roentgenograms as well as the correct position of the patient's head and shows how to direct the principal ray. The object of the method was to save the roentgenologist from failure caused either by a false placing of the patient's head or by a false directing of the ray in spite of the isometric principle laid down by me.

In addition to the normal position of the dental axis the system also takes account of the high and flat palate and is based on the introduction into roentgenology of the Frankfort level plane, the auriclelabial line and the infraorbital-auricle line, according to which, and also naturally according to the type of roentgenogram, the patient's head is to be placed.

Dental roentgenograms have hitherto been considered as belonging to the most difficult in the domain of roentgenography, and not every roentgenologist mastered the technic of the art in such wise that he could guarantee a successful picture before the development of the plate. This table has not only removed difficulties, existing until now, but has even simplified to such

*Read before the First Polish Dental Congress, Lwów, July, 1923. Published in *Polska Dentystyka*, August 1, 1923, p. 314.

†See also: Beiträge zur intra-oralen Aufnahme-technik-Aufnahmen mittels einer Orientierungstafel etc. Fortschritte auf dem Gebiete der Roentgenstrahlen. Bd. XIX, 1912, p. 200.

an extent the hitherto difficult task of directing the principal ray in dental roentgenography that it is now possible to entrust to assistants the taking of roentgenograms in which, formerly, personal individuality played a considerable rôle.

Failures were impossible where there was a certain exactness in the regular maxillary conformation. Though this technic did not ensure absolute precision with regard to the length of the teeth within a range of from one to five millimeters, it proved sufficient for ordinary purposes of diagnosis. I have given the special methods for indicating exactly the length of the teeth in my manual.* Differences of length in the teeth give most trouble in the irregularly built jaws, as for instance when the bite is deep and the maxillary jaw is protruding (prognathia). This problem, however, could be solved only after the application of various methods to the three position planes and an examination of the position of the dental axes, research which it was not possible to carry out until within the last few years.

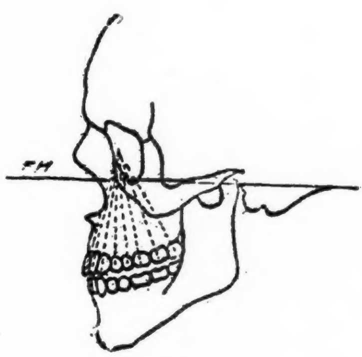


Fig. 1.

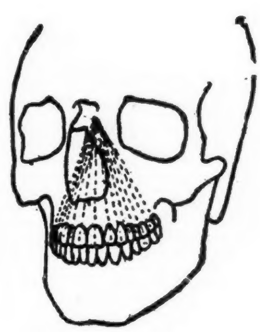


Fig. 2.

Figs. 1 and 2.—Position of the dental axes in the maxillary jaw. (According to G. Villain†.)

The position of the dental axes, especially those of the front teeth, in relation to the Frankfort level, forms the basis of a solution of the problem as to the proper directing of the principal ray in taking roentgenograms of irregularly built jaws.

II

In regularly built jaws the axes of the front teeth show a slight backward inclination. The prolongation of the dental axes cross more or less at a certain point behind the nasion. (See Figs. 1 and 2.) The axes of the maxillary teeth (2-8) as also those of the mandibular ones (5-8) show a convergence towards a sagittal plane.

In Fig. 1 is shown the Frankfort level *FH*, so that the teeth stand in the base of a cone, so to speak, whose apex is situated in the median plane and more or less on the horizontal plane of the naison, the base of the cone coinciding with the bite plane of the teeth. The mantle of the cone may be pro-

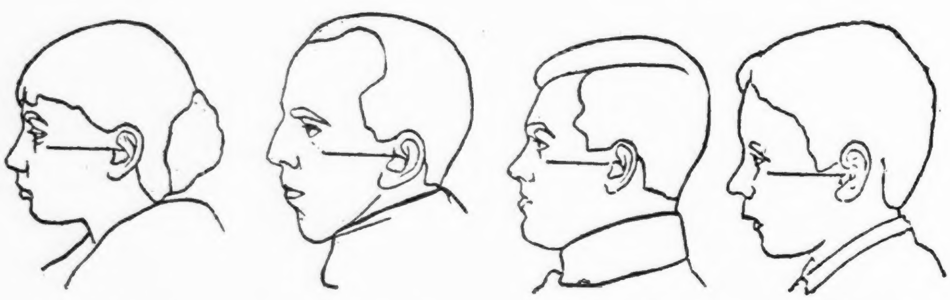
***Die Roentgenuntersuchung der Zähne und der Kiefer,* Leipzig (Ambrosius Barth), 1913, p. 13.

†Villain, Gorges: *Mécanisme de la mastication humaine.* Revue belge matologie, 1921, p. 249. Figs. 1 and 2 are taken from Villain.

longed in the neighborhood of the mandibular molars. I shall devote a special work to certain departures from this principle which is given in outline by *Villain.* Maxillary 'irregularities are best ascertained by placing the patient's head in a normal position, i.e., by applying the Frankfort level horizontally. For this purpose it is necessary to indicate, with the dermatograph on the patient's face, the highest points of the aural apertures and the lowest points of the infraorbital ridges, joining these four points by a line. In this manner we indicate the horizontal plane *FH.* If only a general idea of the irregularity is desired, it is necessary only to indicate the above mentioned points with the fingers—the index and the little finger stretched apart—and direct the *FH* plane to the level.

The *FH* line passes through the cheek bone and the zygomatic process.

After becoming accustomed to inspecting maxillary irregularities in this position a glance suffices to ascertain them even with the jaws closed. Fig. 3 shows the most frequent irregularities with schematic profiles; Fig. 6 the position of the dental axes in analogous order.



1. Deep bite. 2. Open bite. 3. Progenia. 5. Prognathia.

Fig. 3.—Face profiles with maxillary irregularities applied to the level of the Frankfort plane.

In the case of protruding maxillary jaws—prognathia—the maxillary incisors are spatulate (No. 5), while in No. 2, where the bite is open, they are almost vertical.

There is a gap between the maxillary and mandibular incisors. In No. 1, we have also a deep bite; the crowns of the maxillary incisors in this case lean backwards, while the processus alveolaris and the apices of the teeth incline forwards. The prolongations of the incisors in this position do not cross behind but *in front* of the nasion (*Cieszyński*).

The features of maxillary irregularity are still more marked when we examine at the same time the mandible (Figs. 3 and 6).

In progenia the mandible protrudes markedly, the infraorbital region being as it were sunken. In the normal jaw (Fig. 6, No. 4) the chin is somewhat recedent in relation to the maxilla; the whole profile, however, shows a harmonious outline.

In the case of the open bite (Fig. 3, No. 2) the chin recedes somewhat, while with the deep bite and prognathia (Fig. 3, Nos. 1 and 5) this peculiarity is quite marked. The height of the lower part of the face (*prosthion-gnathion)* is greatest with the bite open, shortest with the bite closed. In this

type of irregularity the cutting edges of the teeth bite behind the maxillary incisors in the region of the neck, sometimes even into the palate.

Having ascertained these features, we shall have little difficulty in recognizing any irregularity in any particular case even before turning back the lips or noting the position of the maxillary teeth in their relation to the mandibular ones.

It is of the greatest importance to ascertain maxillary irregularities before taking the roentgenogram *if we wish to show the normal length of the teeth* and not satisfy ourselves with a mere approximate idea of their length.

III

It is a principle of roentgenography that the best roentgenograms are obtained when the chief ray falls perpendicular, i.e., at an angle of 90° to the photographic plate, the chief axis of the object lying parallel with the photographic plate. According to the principle *propounded by me in 1907 (rule of isometry), the shadow of a tooth placed obliquely to the film corresponds to the normal length, in so far as the chief ray falls perpendicularly to the plane*

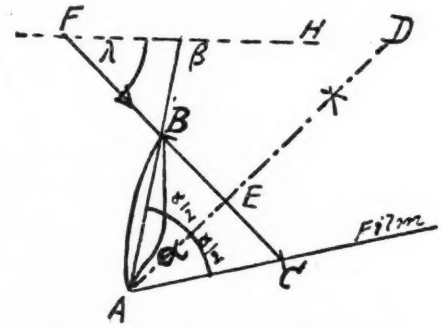


Fig. 4.—Rule of Cieszyński's isometry:

α = angle formed by dental axis and film.
AD divides angle α in two equal parts.
FE perpendicular to *AD*.
AC = *AB*.

*which halves the angle created by the axis of the tooth and the photographic plate.** (Fig. 4.)

The direction of the chief ray (angle λ) depends on the inclination of the tooth axis to the plane of the plate.

By measuring the angle at which the chief ray diverges from the horizontal, and thus ascertaining the angle of the tooth axis in its relation to the level of the axis of the Frankfort plane *FH* ($\measuredangle\beta$) as well as the angle at which the photographic plate diverges from the same plane ($\measuredangle K$) the angle λ may be calculated on the basis of a mathematical model.

Calculations of the angle of the chief ray λ with the angle of tooth axis β and plate inclination K (Fig. 5).

*Cieszyński. Ueber die Einstellung der Roentgenröhre bei Zahnaufnahmen. Neue Hilfsapparate. Corresp. f. Zahnärzte, 1907, p. 158.

This basic rule is erroneously ascribed to *Dieck* who mentions it only in 1911 *without giving the name of the author* "Anatomie und Pathologie der Zähne im Roentgenbilde mit besonderer Berücksichtigung der Aufnahmetechnik." It is mentioned by *Pordes:* "Die Radiographische Darstellung der einzelnen Zähne und der Kiefer," 1919, p. 7. "This law was first formulated by *Cieszyński* but goes by the name of Dieck's Law." In America this law is attributed to Weston Price.

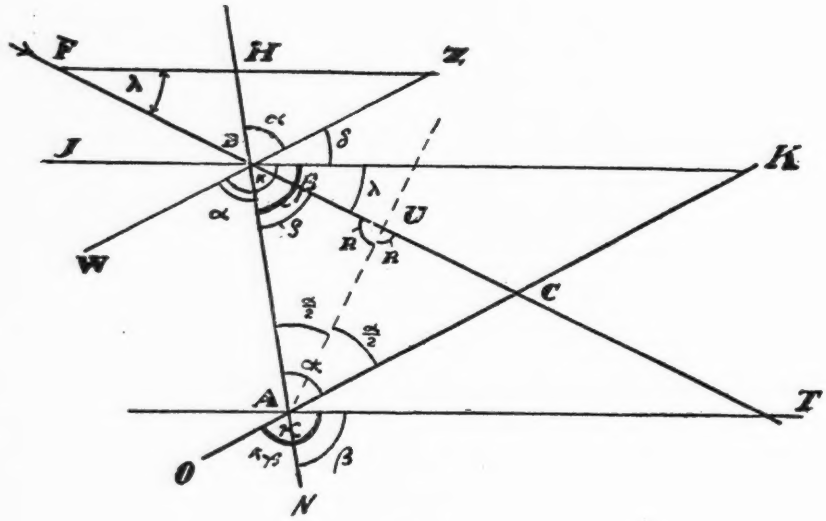


Fig. 5.

Proposition:

AB = *tooth*

AK = *position of film*
AC = *length of tooth on photo*
AC = AB

AU *bisects* $\sphericalangle\ \alpha$
IK ∥ FH

WZ ∥ OK

Explanation:

$\sphericalangle$ HFB = λ = angle formed by chief ray in relation to *FH* (corresponding to angle-square of tubestand).

$\sphericalangle$ ABK = β = angle formed by tooth axis and *FH*

$\sphericalangle$ BAC = α = angle formed by tooth axis and film

2 R = 180°

Data:

$\sphericalangle\ \beta$ (angle of dental axis to *FH* or *K*)
$\sphericalangle\ \kappa$ (angle of film to *FH* or to a line parallel to it)
? λ

Proof:

$\sphericalangle$ WBK = OAT = $\sphericalangle\ \chi$
$\sphericalangle$ WBA = HBZ = BAK = α

$\sphericalangle$ HFB = KBT = λ

$\sphericalangle$ WBA + $\sphericalangle$ ABT + TBK + $\sphericalangle$ KBZ = 2 R
$\alpha + \rho + \lambda + \delta = 2\text{ R}$
1) $\lambda = 2\text{ R} - (\alpha + \rho + \delta)$

2) $\sphericalangle$ OAT = χ
$\sphericalangle$ OAN = $\chi - \beta$
$\sphericalangle$ OAN = BAK = α
$\sphericalangle\ \alpha = \chi - \beta$

3) ρ is calculated thus: Δ AUB
$$\rho = 2\text{ R} - \left(\text{R} + \frac{\alpha}{2}\right)$$
$$\rho = \text{R} - \frac{\alpha}{2}$$

4) $\sphericalangle$ ZBK + KBW = 2 R
$\sphericalangle\ \delta + \chi = 2\text{ R}$
$\sphericalangle\ \delta = 2\text{ R} - \chi$

$$1)\ \lambda = 2\,R - a - \rho - \delta$$

$$\lambda = 2\,R - \left(\chi - \beta\right) - \left(R - \frac{a}{2}\right) - (2\,R - \chi)$$

$$\lambda = 2\,R - \chi + \beta - R + \frac{a}{2} - 2\,R + \chi$$

$$\lambda = \beta + \frac{a}{2} - R = \beta + \frac{a}{2} - 90°$$

$$\lambda = \beta + \frac{\chi - \beta}{2} - 90°$$

Example: Case 1, deep bite, film in bite position. (Fig 7.)

$\beta = 80°;\ \chi = 153°;\ \ ?\ \lambda$

$$\lambda = \beta + \frac{\chi - \beta}{2} - 90°$$

$$\lambda = 80 + \frac{153 - 80}{2} - 90 = \frac{73}{2} - 10$$

$$\lambda = 36\tfrac{1}{2} - 10 = 26\tfrac{1}{2}°$$

UPPER JAWS—INCISORS

Gnathostatic methods have enabled us to examine the position of the dental axis as well as the bite curve in relation to the Frankfort plane level (*FH*). On the basis of a series of profiles obtained by orthognathic models or casts, I fixed the dimensions of angle β for the maxillary and mandibular jaws to *FH* in the various types of irregularity of bite.

The method of examination was as follows: The orthognathostatic models were intersected in a radial direction to the processus alveolaris in the region of the teeth 1, 3 and 6. I then transferred the copy of the profile thus obtained to a glass plate and afterwards to transparent paper; then I reconstructed graphically the axis of the tooth from the configuration of the crown. For the regular bite, however, I obtained at once a profile by means of an anatomic preparation.

The variations in size of angle β in the various types of irregularity are considerable, while within the range of each separate type they are insignificant. For each irregularity, I took into account the mean dimensions; therefore, the irregularities may be grouped in the following order according to the size of angle β in the maxillary jaw and according to the inclination of the film (angle β) to *FH* (Figs. 6 and 4).

Direction of Chief Ray and Length of Shadow of the Teeth on Film.—In Fig. 9 I assumed dental axis *AB* to be invariably perpendicular to *FH:* as the mean of the angles of the film from the dental axis (*angle* a) is 33° : line AD.

TABLE I

FILM AT AN ANGLE TO FH		∡ λ FOR THE CHIEF RAY TO OBTAIN THE LENGTH OF THE TOOTH	
		Actual Length	Shortened
153°	*1.* deep bite	27°	56°
166°	*2.* open bite	37°	65°
166°	*3.* progenia	40°	70°
158°	*4.* normal bite	*39°*	*80°*
170°	*5.* prognathic	60°	105°

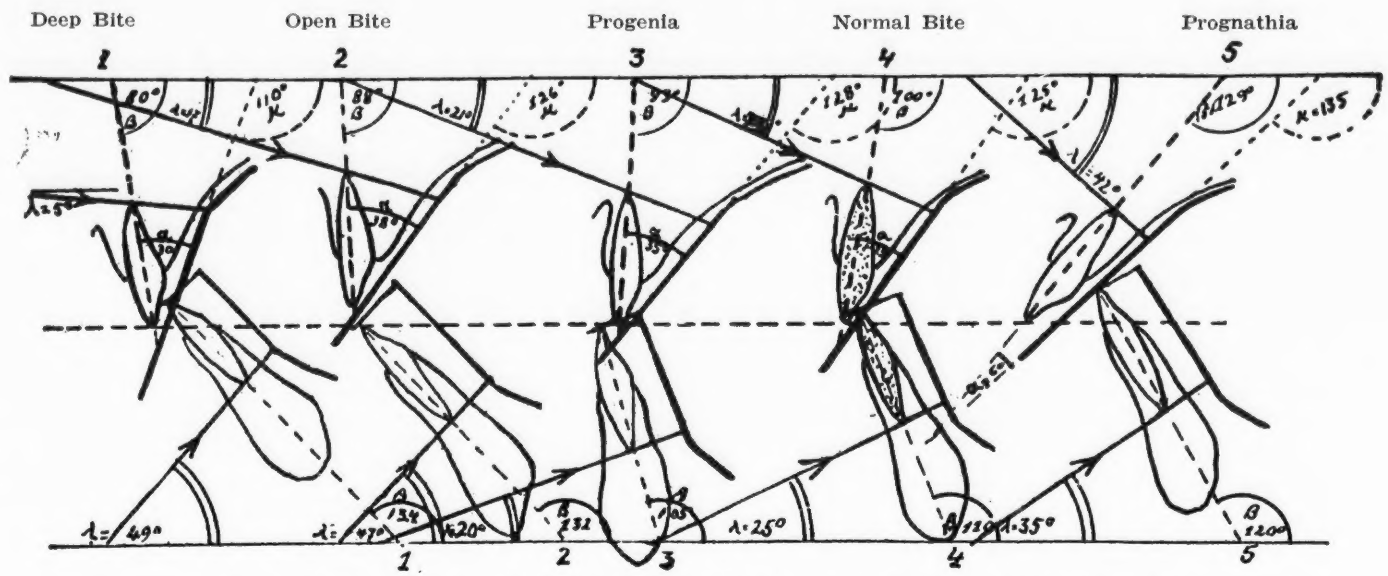


Fig. 6.—Radial profiles of jaws with irregular bite according to orthognathostatic models.

FH Frankfort plane level. Slope of dental axes in relation to *FH* is indicated by the size of angle β. The arrows indicate the direction of the chief ray (angle λ); for front teeth $\underline{21 \mid 12}$ with film against palate.

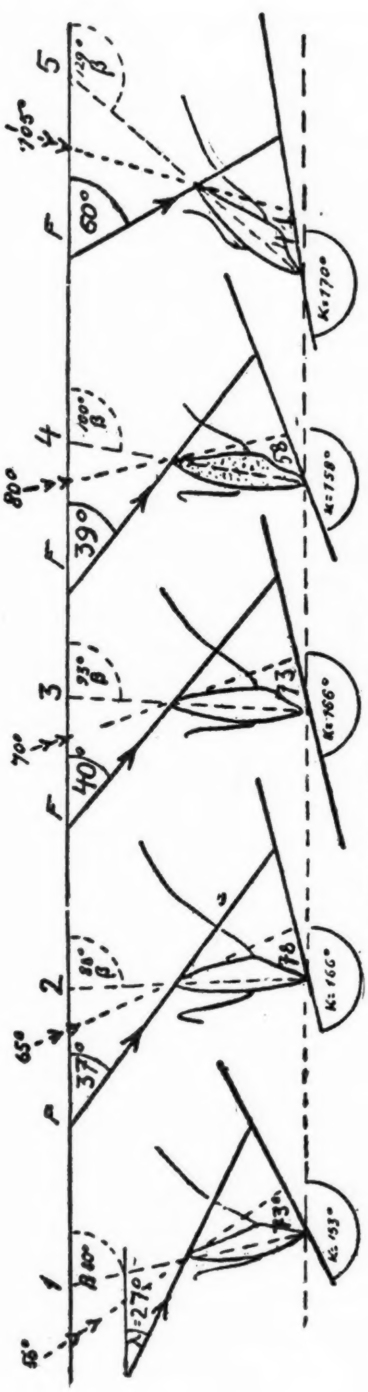


Fig. 7.—Film in bite position and its relation to *FH*.

The full line of the chief ray shows shadows of the actual length of the tooth, while the dotted lines show the same, shortened by more than a half.

The segment passing through B (the apex of the root) and intersecting the film in the position peculiar to all irregularities indicates the length of the shadow corresponding to the actual length of the tooth. (In the present example the length of the tooth is assumed to be 2 cm.)

The Arabic numbers 1 to 5 indicate the position of the plate against the

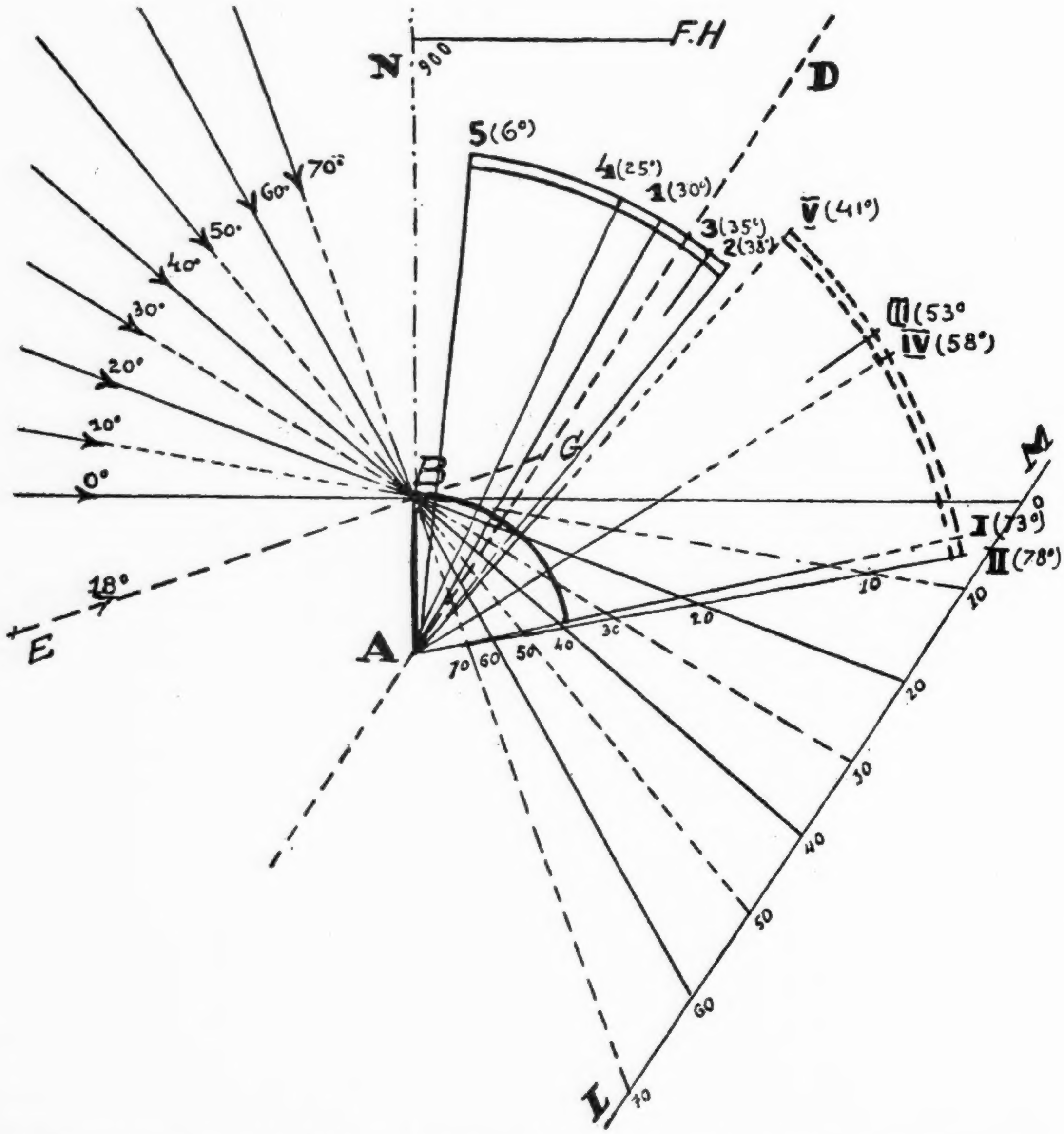


Fig. 9.—Compare with Table II. Variation in length of tooth following upon change of angle λ.

palate in various types of jaws. The number in brackets, therefore, refers to the dimensions of angle *a*.

The Roman numbers I to V indicate in like manner the position of the bite plate.

The numbers beside the lines showing the direction of the chief ray indicate angle λ, i.e., the angle of the chief ray to the horizontal. These figures

TABLE II

VARIATIONS IN THE LENGTH OF THE SHADOWS OF THE TEETH IN CHANGES OF ADJUSTMENT OF CHIEF RAY. (SEE FIG. 9)

	8	7	6	1	1	2	3	4	5
	TOOTH SHORTENED BY		λ MEASURED BETWEEN	$\measuredangle a$ *	BITE	DIFFERENCES OF DEGREES λ °	λ MEASURED BETWEEN	TOOTH LENGTHENED	
	%	mm.						By mm.	i. e. % of the length
FILM IN BITE POSITION	25	5	50° a 40°	73°	*I deep*	o 10°	40° a 30°	6.0	30
	45	9	60° a 40°			o 20°	40° a 20°	16.0	80
	17.5	3.5	40° a 30°	58°	*IV normal*	o 10°	30° a 20°	5.0	25
	35.0	7	50° a 30°			o 20°	30° a 10°	11.0	55
	12.5	2.5	30° a 20°	41°	*V prognathia*	o 10°	20° a 10°	3.5	17.5
	22.5	4.5	40° a 20°			o 20°	20° a 0°	5.5	27.5
				**					
FILM LYING AGAINST PALATE	3.5	0.7	20° a 10°	30°	*1 deep*	o 10°	10° a 0°	0.70	3.5
	7.5	1.5	30° a 10°			o 20°	+10° a —10°	1.5	7.5
	7.5	1.5	20° a 10°	25°	*4 normal*	o 10°	10° a 0°	1.0	5.0
	15.0	3	30° a 10°			o 20°	+10° a —10°	2.0	10.0
	10.0	2	20° a 10°	6°	*5 prognathia*	o 10°	10° a 0°	2.0	10.0
	20.0	4	30° a 20°			o 20°	10° a —10°	4.0	20.0

*Fig. 7. **Fig. 6.

correspond to the scale on my tubestand and show the angle of the slope from the perpendicular direction of the chief ray to the axis of the tooth.

The axes of the teeth incline backwards in the following order in the various types of irregularity:

1. Deep bite.
2. Open bite.
3. Progenia.
4. Normal bite.
5. Prognathia.

The vault of the palate lowers in almost the same order in its relation to *FH*, while the axis of the tooth approaches the vault, whereby angle *a* is lessened (from 38° to 6°, or 78° to 41°). (See Figs. 6 and 7.)

The variable positions of the tooth axis on the film had a decisive influence on the direction of the chief ray.

In what ratio the length of the tooth changes in its alteration of angle λ, on adjusting the chief ray in relation to each 10° of angle λ may be seen from Fig. 9 and Table II; in the latter the dimensions are conceived in numbers, while in Fig. 9 they are represented graphically.

The greater the angle *a*, the greater are the differences between the shadow obtained on the plate and the actual size, if we diverge from the most advantageous adjustment of the chief ray.

In Fig. 9, I have assumed a permanent adjustment of the tooth axis AB to the Frankfort level FH at an angle of 90°, sketching *the positions of the film* in the case of the normally built jaw (Fig. 6, No. 4) and of the irregular jaws

(adjustment of films adhering to palate : 5 . 1, 3; 2 and in the bite position V-I).

The segment passing through B and intersecting the plates shows the most advantageous adjustment of the chief ray in degrees.

From the constructive Fig. 9, it will be seen that with the increase of angle α, that is, *the increase of the inclination of the film from the apex of the tooth B, the differences of length of the shadow rise rapidly.*

(a) These differences will be least with a close-lying film and much greater with a film adjusted to the bite.

(b) The greatest differences are to be found in the deep bite (I and 1); the smallest in prognathia (V and 5).

(c) The differences appear most markedly with a decrease of angle λ, that is, after exceeding the actual length of the tooth (Table II, Column 5), the smallest difference appearing with a shortening of the actual length (Table II, Column 8), that is, with an increase of angle λ.

Fig. 10 gives the adjustments of the chief ray according to the various irregularities, the differences of size of angle λ being here pronounced.

On segment *A* are the directions of the chief ray with the film lying against the palate, on segment *B* they are shown with the film in the bite position.

If we assume that in typical roentgenograms the size ought not to be under one-fifth of the actual length, it will be understood that care must be taken to avoid a mistake exceeding 8° in roentgenograms of incisors, in the adjustment of the film: while the film is laid flat against the palate there may result an error of 20°. Table II contains exact data in percentages regarding the length of the tooth.

In practice we mostly make use of roentgenograms showing one-tenth of the curtailment of the normal length of the teeth, adjusting the chief ray to a plane preferably a little too steep than too level in order thus to limit as much as possible the extent of the error.

In pursuance of this principle I have given the dimensions of angle λ *in position Table VI which serves for practical purposes.*

The chief ray ought to be most exactly adjusted with the deep bite (No. 1) and with the open bite (No. 2), if we wish to obtain the normal length.

TABLE III

ROENTGENOGRAMS OF MAXILLARY INCISORS

FILM LYING AGAINST PALATE			BITE	$\sphericalangle \beta$	FILM IN BITE POSITION		
Calculated					Calculated		
$\sphericalangle \lambda$ [1]	$\sphericalangle \alpha = \chi - \beta$	$\sphericalangle \chi$			$\sphericalangle \chi$	$\sphericalangle \alpha = \chi - \beta$	$\sphericalangle \lambda$ [1]
5°	30°	110°	1) Deep bite	*80°*	153°	73°	*27°*
17°	38°	126°	2) Open bite	*88°*	166°	78°	*37°*
21°	35°	128°	3) Progenia	*93°*	166°	73°	*40°*
23°	25°	125°	4) *Normal bite*	*100°*	158°	58°	*39°*
42°	6°	135°	5) Prognathia	*129°*	170°	41°	*60°*

[1]) $\sphericalangle \lambda = \beta + \frac{K - \beta}{2} - 90° = \beta - 90° + \frac{\alpha}{2}$

So far, the most frequent failures have occurred in taking these roentgenograms on a film in the bite position.

In taking roentgenograms on films in the bite position the occlusion curve in its relation to plane *FH* is of primary importance. This occlusion curve in the case of a normally shaped skull, never has a level course but rises upward in its hinder section (Fig. 6). This curve is flattest in prognathia and steepest in the deep bite: other maxillary irregularities occupy intermediate positions. (Table II.)

Angle α in Table III is calculated as follows (Fig. 8).

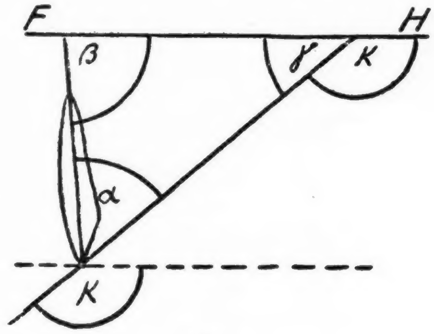


Fig. 8.

$$
\begin{aligned}
\chi + \gamma &= 2\,\mathrm{R} \\
\gamma &= 2\,\mathrm{R} - \chi \\
\alpha + \beta + \gamma &= 2\,\mathrm{R} \\
\alpha &= 2\,\mathrm{R} - \beta - \gamma \\
\alpha &= 2\,\mathrm{R} - \beta - (2\,\mathrm{R} - \chi) \\
&= 2\,\mathrm{R} - \beta - 2\,\mathrm{R} + \chi \\
\alpha &= \chi - \beta
\end{aligned}
$$

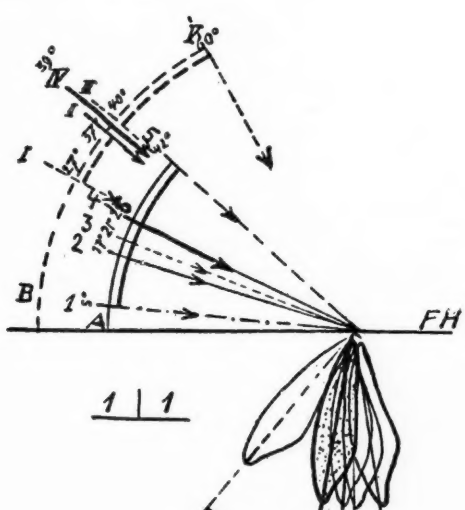


Fig. 10.—The incisors in the case of the normal bite as also in irregular bites, in their relation to *FH* are so placed that they cover each other's apices.

In segment *A* the arrows indicate the direction of the chief ray falling upon the film which lies against the palate.

The arrows on segment *B* show the direction of the chief ray falling upon the film in the bite position.

1. Deep bite; 2. Open bite; 3. Progenia; 4. Normal bite; 5. Prognathia.

MAXILLARY CANINES AND PREMOLARS

The differences of axis in the maxillary canines are not so striking in irregularities 1 to 5 as in the case of the incisors; they show variations of from 92° to 105°, that is, a range of 13°. (Fig. 11.) Hence angle λ varies less—25° to 38°—with the film lying against the palate.

In practice the fact must be considered that the canines are placed on the bend of the dental crescent, wherefore it is usually impossible to lay the

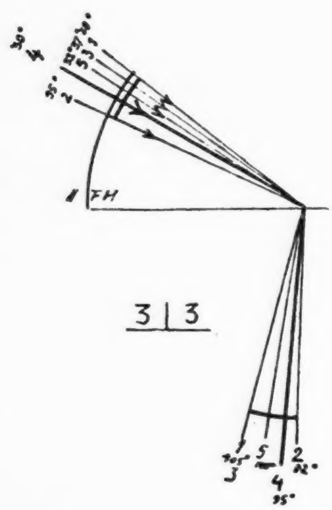


Fig. 11.—Axes of upper canines in relation to *FH* and direction of chief ray with film lying against palate. (See Table IV.)

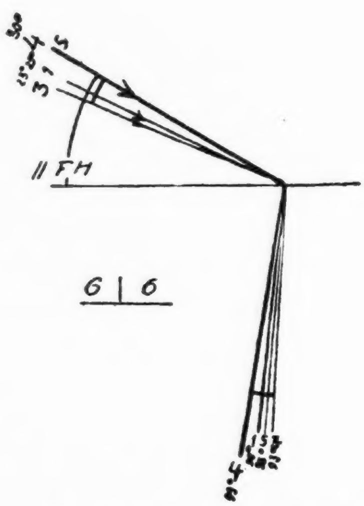


Fig. 12.—Axes of premolars and direction of chief ray with film lying against palate. (See Table IV.)

Table IV

Roentgenograms of Teeth with Film Lying Against Palate

Angle of chief ray angle λ	Axis of teeth 3 | 3 angle β		Axis of teeth 6 | 6 angle β	Angle of chief ray angle λ
38°	105°	*1.* deep bite	96°	25°
25°	92°	*2.* open bite	95°	30°
37°	105°	*3.* progenia	93°	23°
30°	*95°*	*4. normal bite*	*99°*	*30°*
33°	100°	*5.* prognathia	95°	30°

film exactly against the palate, especially in the case of larger films. For this reason it is necessary to direct the chief ray at a steeper angle towards the film.

In the case of the premolars and molars the axis varies scarcely 6° (Fig. 16), so that with angle λ = 30° we obtain shadows of teeth corresponding to the actual length.

THE MANDIBULAR JAW

In taking roentgenograms of the mandibular jaw and making use of my film holder, the axes of the teeth rest almost parallel with the film. The bottom of the film, however, will be inclined towards the tongue on account of

the resistance offered by the genioglossus muscle; angle a then ranges from 10° to 15°.

In the case of side roentgenograms the film goes deeper, hence it is possible to include even the edge of the jaw in the region of the molars as the mylohyoid muscle offers less resistance.

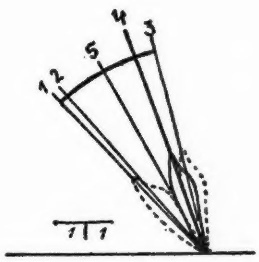


Fig. 13.

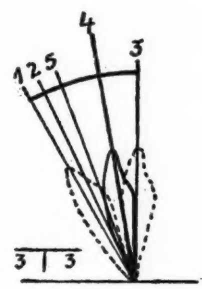


Fig. 14.

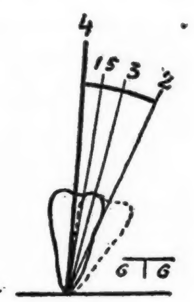


Fig. 15.

Figs. 13, 14 and 15 show the position of the canines, premolars, and molars in the various mandibular irregularities.

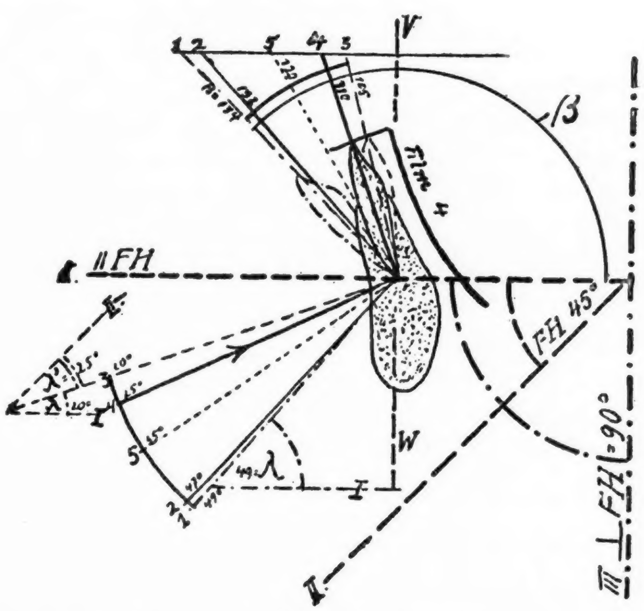


Fig. 16.—*Direction of chief ray (angle λ) in exposures of the mandibular front teeth.* The profile of the normal jaw (No. 4) is shown with film fixed against alveolar process by holder. 1, 2, 3, 5 which represent the slopes of dental axes in the irregular jaws, show angles of 105° to 134° (angle β) in their relation to *FH*. If we turn the figure round 45° so that *FH* assumes an angle of 45° to the level, we shall obtain the position in which the jaw ought to lie in taking photographs of the mandibular teeth. In direction 3 of the chief ray angle λ_1 corresponds to position II.—(in this case 25°) corresponds to 45° in position I, that is, provided the Frankfort level is in a horizontal position.

Example: *FH* at an angle of 45°. λ_1 45°—20°=25°. According to this figure λ_1 may similarly be calculated for a different position of the dental axes.—See also Table V.

Marked differences, however, are to be met with in the position of the dental axes of the mandibular jaw in relation to the plane of the Frankfort level, hence an analysis of the exact technic of these roentgenograms deserves some attention on account of the irregularities of bite, especially in the case of roentgenograms taken on films in the bite position. First of all we shall

take a look at the adjustment of the incisor axes to the plane *FH* (Figs. 6 and 16). The front teeth axes more than any others fall perpendicular to *FH* (as in Fig. 16, nearest to line VW) in cases of progenia, while in jaws of other build the teeth incline more forward, the apices of the roots having a backward slope in the following order: In prognathia the angle β is of 120°, in the normal bite 110°, in progenia 105°, in open bite 132°, in deep bite 134°.

The adjustment of the chief ray with the film fixed by the film-holder is likewise given in Fig. 16.

Fig. 6 and Table V contain the dimensions of angle β, i.e., the inclination of the lower dental axes towards plane *FH*.

Angle λ (adjustment of chief ray) varies within a range of 30° in the various irregularities of the incisors and canines with the film lying against the alveolar process, while in exposures of the premolars and molars the range is scarcely 20°.

By placing the film-holder between the teeth with a bite-cork 5 mm. in height, the jaws are separated to the thickness of the cork *while the angle of the dental axes in its relation to FH, increases from 0° to 10°* (see Note 2 to Table V), the axes of the front teeth undergoing the greatest variation, 10° with normal bite as against 0° with open bite.

Angle β is similarly influenced by the insertion of the film between the teeth or of the glass photographic plate in the bite position. The jaws do not open so widely, hence angle β also increases but to a less extent than with the application of the film-holder in taking roentgenograms with the film against the alveolar process.

Variations in angle β in the case of bite films range from 106° to 135°, that is, 29° in the various irregularities.

The dimensions of angle λ for the canines and lateral teeth are given in Table III.

TABLE V

FH IN HORIZONTAL POSITION; FILM AGAINST ALVEOLAR PROCESS							FILM IN BITE POSITION TO $\overline{2\ 1 \mid 1\ 2}$		
Bite	Axes $\overline{2\ 1 \mid 1\ 2}$ $\measuredangle\chi$	$\measuredangle\lambda$ 1)	Axes $\overline{3 \mid 3}$ $\measuredangle\beta$	$\measuredangle\lambda$	Axes $\overline{8— \mid 4—8}$ $\measuredangle\beta$	$\measuredangle\lambda$	$\measuredangle\chi$	$\measuredangle\beta$	λ_1 3)
1 deep	134° (*137°*) 2)	—49°	120°	—35°	81°	—9°	27°	135°	—81°
2 open	132° (*132°*)	—47°	116°	—31°	65°	—25°	14°	132°	—73°
5 prognathia	120° (*122°*)	—35°	110°	—25°	80°	—10°	10°	122°	—66°
4 *normal*	110° (*120°*)	—25° —(30°)	100°	—15°	85°	—5°	22°	112°	—67°
3 progenia	105° (*108°*)	—20°	90°	— 5°	75°	—15°	14°	106°	—60°

1) $\lambda = \beta - 90 + \frac{a}{2}$; a in $\overline{3\,2\,1 \mid 1\,2\,3} = 10°$; a in $\overline{8—4 \mid 4—8} = 0°$; $a = \chi - \beta$.

2. The *italics* indicate the size of angle β with film-holder inserted; by inserting the holder $\measuredangle\beta$ is increased the thickness of the cork 5 mm. in (1) 3°, in (2) 0°, in (5) 2°, in (4) 10°, in (3) 3°. *The scale ranges from 0-10°.*

3. $\measuredangle\lambda_1$ is calculated by equation in Fig. 16, i. $\lambda = \frac{\beta + K}{2}$

The divergence of the chief ray from the horizontal, or in other words, the angle λ, may be calculated in the following way from angles β and K in roentgenograms of the mandible.

Calculations of the $\sphericalangle$ and λ for roentgenograms of mandible with angles β and K. (Fig. 17.)

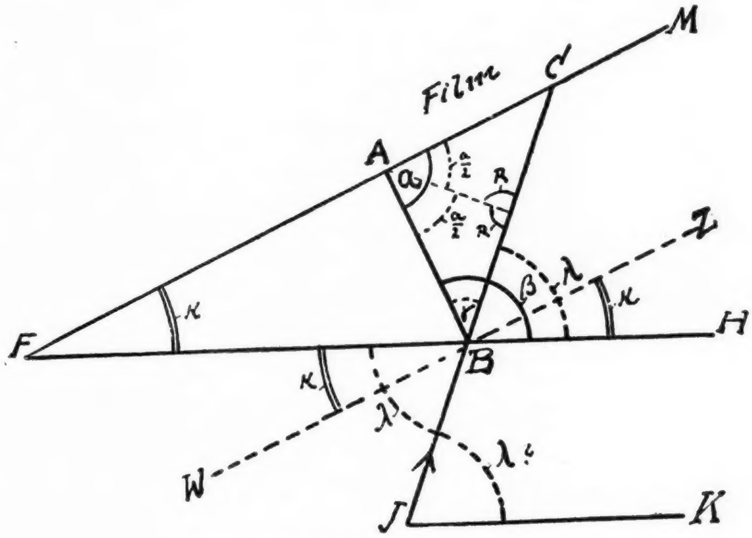


Fig. 17.

Proposition: AB tooth axis; B apex.
FM Film in bite position.
χ angle of FM to FH (horizontal).
$\beta = \sphericalangle$ ABH i. e. angle created by axis of tooth and horizontal.
$a = \sphericalangle$ CAB i. e. angle created by film and axis of the tooth.
λ ? (angle of chief ray to horizontal).

Proof:

$$\lambda = BJK = FBJ$$
$$\chi = MFH = FBW = ZBH$$
$$a = CAB = ABW$$
$$\gamma = ABC$$

$$WBA + ABZ = 2\,R$$
$$ABZ = ABH - ZBH$$
$$= \beta - \chi$$
$$a + \beta - \chi = 2\,R$$
$$2)\quad a = 2\,R - \beta + \chi$$

$$WZ \parallel FM$$
$$F\gamma\ \Delta\ CAB : AC = AB$$
$$1)\quad \gamma = R - \frac{a}{2}$$

$$WBA = BAC = a$$
$$FBA = WBA - FBW$$
$$FBA = a - \chi$$

$$JBF + FBA + ABC = 2\,R$$
$$\lambda + a - \chi + \gamma = 2\,R$$
$$\lambda + 2R - \beta + \chi - \chi + R - \frac{a}{2} = 2\,R$$
$$\lambda = \beta - R + \frac{a}{2}$$
$$2\lambda = 2\beta - 2\,R + 2\,R - \beta + \chi$$
$$2\lambda = \beta + \chi$$
$$\lambda = \frac{\beta + \chi}{2}$$

TECHNIC FOR EXACT INTRAORAL X-RAY ROENTGENOGRAMS

From the preceding it will be seen that great precision is necessary in taking intraoral exposures.

But it becomes easy and accessible to every one with the reults of the above study put into a chart of angles and table with positions of head and directions of chief ray (Table VI, Fig. 18), if we make use of a ***tubestand*** (Fig. 19) which enables us to direct with precision the chief ray.

TABLE VI

SCALE OF ANGLE λ

	FILM IN BITE POSITION		FILM AGAINST PALATE		
	Front Teeth		Incisors	Canines	Molars and Premolars
MAXILLARY JAW	35°	*1.* Deep bite	20°	50°	40°
	50°	*2.* Open bite	30°	40°	45°
	50°	*3.* Progenia	35°	50°	35°
	50°	*4. Normal bite*	40°	45°	45°
	75°	*5.* Prognathia	50°	45°	45°
MANDIBULAR JAW	0°	*1.* Deep bite	–20°	–10°	+25°
	+5°	*2.* Open bite	–15°	0°	+10°
	+20°	*3.* Progenia	+ 5°	+20°	+20°
	+15°	*4. Normal bite*	0°	+10°	+30°
	+15°	*5.* Prognathia	– 5°	0°	+25°
	FH perpendicular		*FH* at angle of 45° Δ		

– indicates upward direction of chief ray.
+ indicates downward direction of chief ray.
The angles are calculated by means of Tables III, IV, V and Table II so as to obtain roentgenograms of tooth shortened on an average by 1/10 of the actual length.

According to the preceding example we have calculated the angle λ for the film in the bite position in exposures of the front teeth of the mandibular jaw (see Table V). In the year 1907 I constructed a tubestand of this kind, having degrees indicated and on that occasion I also gave a description of an apparatus for *indicating the chief ray* (invented by *Schmitt* and *Cieszyński*, Fig. 19) which was later in various modified forms imitated by other manufacturers. The scale for angle λ in this apparatus is so graded that 0° corresponds to the horizontal direction of the chief ray. This anglometer was replaced by Howard R. Raper by an anglo-meter on cone which however, does not alter the principle of the anglo-meter (INTERNATIONAL JOURNAL OF ORTHODONTIA, ORAL SURGERY AND RADIOGRAPHY, 1923, p. 635).

Another condition is *that the patient's head shall be solidly and accurately posed,* resting on a movable headrest (like that of operation chairs). *The plane of head FH should be adjusted parallel with the horizontal in exposures of the maxillary teeth, but at an angle of 45° in taking the mandibular teeth: the head FH is placed perpendicular to the level only in exposures of the front lower teeth taken on the bite film.* For this purpose it is necessary to indicate the line *FH* by dermatographically on the patient's face. *The FH line can easily be fixed at an angle of 45° by means of a common isosceles triangle such as is used in drawing or made of flexible board.* (Fig. 20.)

I announced this principle of a simplified and systematized technic for intraoral radiograms in the year 1912, which was given with slight modifications by Howard R. Raper in the INTERNATIONAL JOURNAL OF ORTHODONTIA, ORAL SURGERY AND RADIOGRAPHY, August, 1923, p. 628. This modification con-

Intraoral Method I-IV. Film Adherent to the Jaw

I.

II.

III.

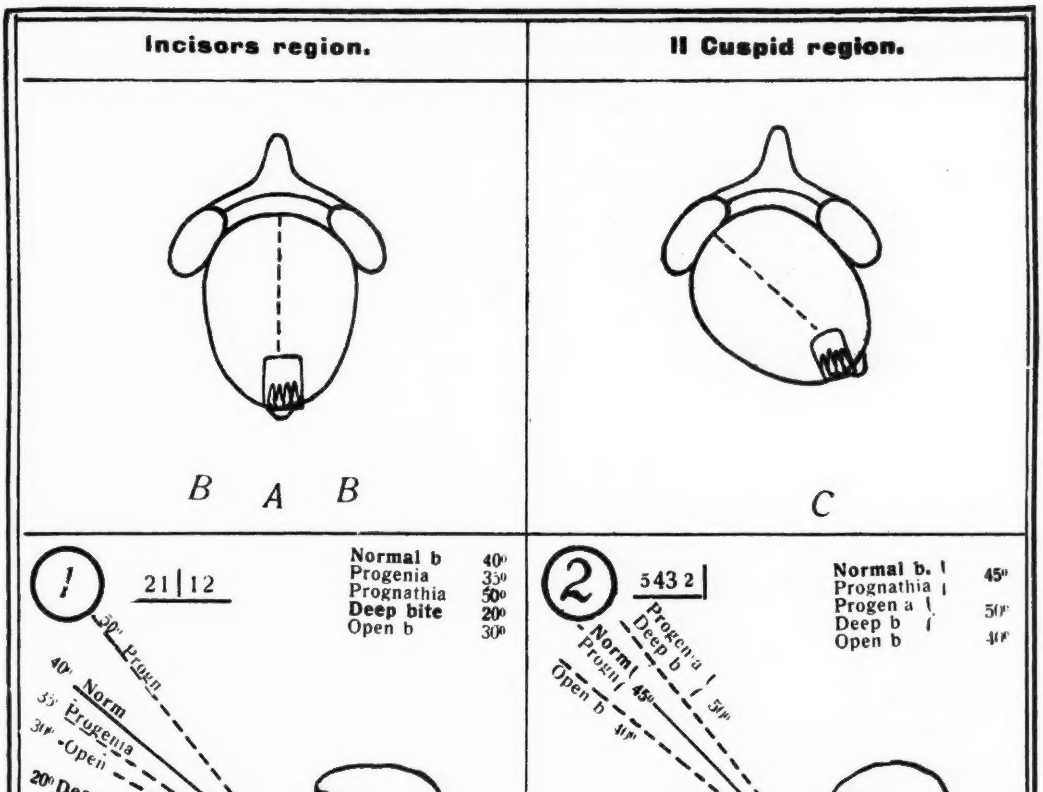


Fig. 18-A.

Intraoral Method I-IV. Film Adherent to the Jaw

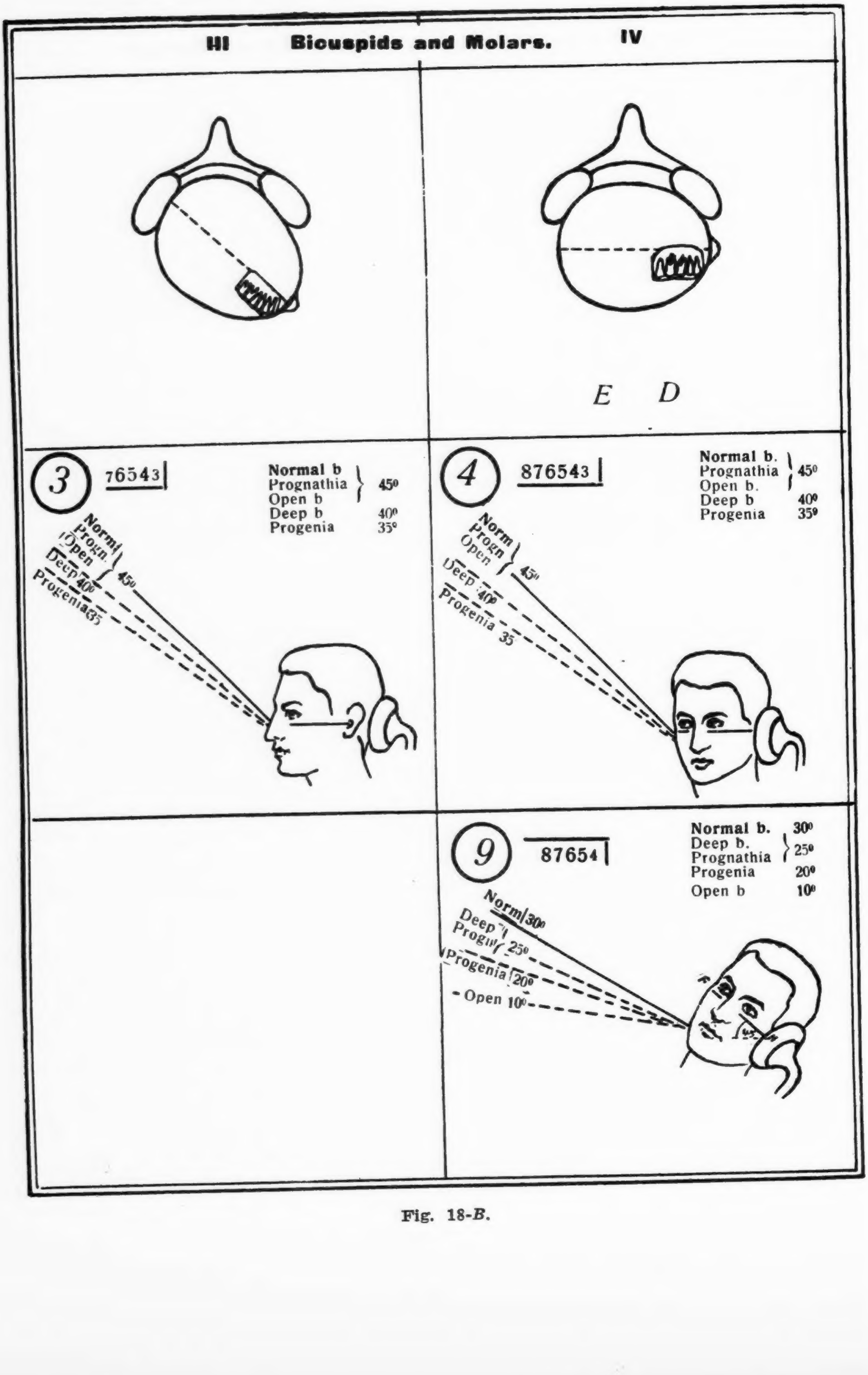


Fig. 18-*B*.

Method V-VI. Film in Biting Position.

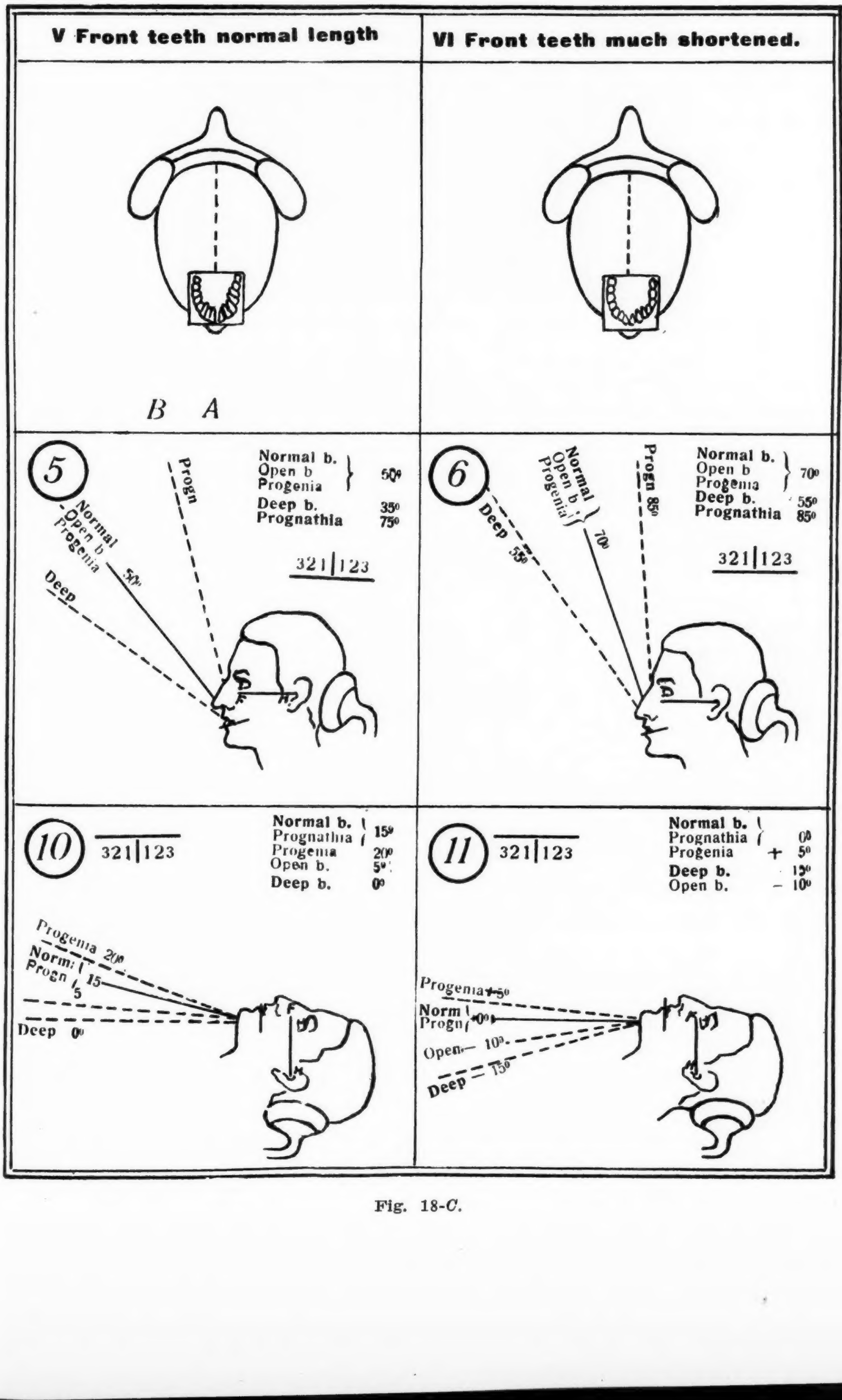


Fig. 18-C.

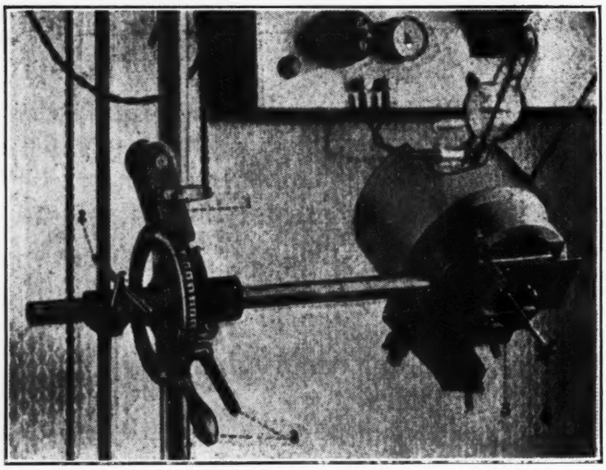


Fig. 19.—Cieszyński's tubestand with anglo-meter for shifting and inclining the x-ray tube.

1. Part enabling operator to turn the tube-holder around the vertical axis and raise or lower it; also shows axis level with screw.

2. Axis on left and right. Also for stereoscopic fixture.

3. Lever with fixing screw for directing the chief ray at the desired angle by the means of Cieszyński's anglo-meter.

4. Schmitt and Cieszyński's apparatus for showing the direction of the chief ray.

5. Automatically closing measuring tape allowing a direct reading of the distance between the antiathode and the plate, being shortened the distance of the anticathode from the front side of the tube box.

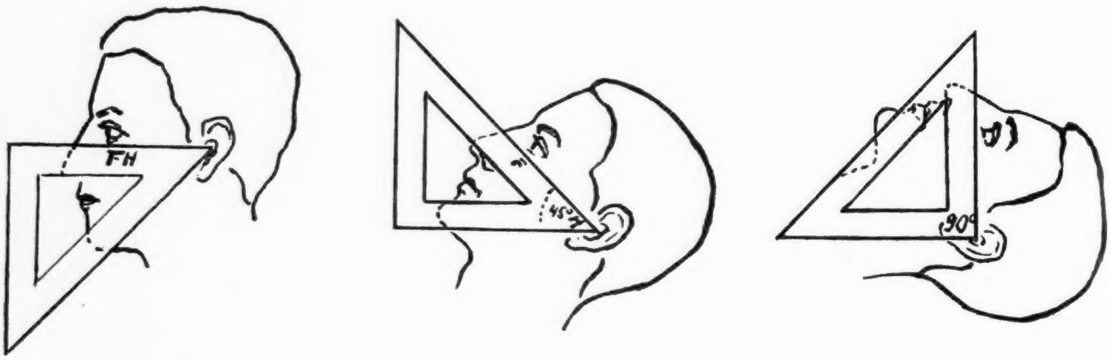


Fig. 20.

sists in the change of the Frankfort level to Camper's line (auricle-nasal line) which also is traced on the patient's face on which the level is fixed.

SUMMARY

1. In the various maxillary irregularities the dental axes run in a different direction from that of the Frankfort level plane.

2. The exact length of the tooth may be reproduced on the film by the rules of *Cieszyński's* isometry.

3. In the typical adjustment of the head (according to line *FH*) the length of the tooth depends on angle β which is formed by the axis of the tooth and line *FH* also on the inclination of the film to *FH* (angle K).

The angle of the chief ray λ (that is, the angle at which the chief ray slopes from the level) is then the following:

$\lambda = \beta - \frac{\kappa - \beta}{2} - 90°$ for the maxilla and

$\lambda = \frac{\beta - \kappa}{2}$ for the mandible.

4. In employing the film-holder angle β changes.
5. The exact adjustment of the chief ray is given in Table IV. The departure from the actual length of the tooth may amount to one-tenth.
6. The farthest departure from the regularly built jaw is found in the front teeth with deep bite.
7. Roentgenograms of the mandible taken on the film in the bite position require more precision than any others.
8. Table VI enables not only the professional radiographer but even other members of the staff to take exact roentgenograms.
9. In taking the mandibular teeth with the film against the alveolar process the patient's head is for practical reasons so placed that line ***FH*** runs at an angle of 45° to the horizontal. This can easily be done by means of a rectangular isosceles triangle, placing it against line ***FH*** marked on the patient's face. In this manner we obtain line ***FH*** perpendicular to the horizontal in taking the mandibular teeth in the bite position (Fig. 17).

This simple method however may be applied only when the stand is fitted with anglo-meter for the adjustment of the chief ray (***Cieszyński's*** tubestand or ***Raper's*** anglo-meter on cone).

A NEW KIND OF X-RAY EXAMINATION FOR PREVENTIVE DENTISTRY*

By Howard R. Raper, D.D.S., F.A.C.D., Albuquerque, N. Mex.

(Concluded from July.)

NOTES

The layman's belief that dentists deliberately bore holes in good teeth is far from the truth. The truth is that the danger the public is in is that the dentist does not find and fill the cavities which are there.

* * * * *

After a tooth has ached a patient hasn't much choice: (1) Aseptic treatment at great expense and none-too-certain results. (2) Septic treatment for a meager fee but with great danger to health. (3) Extraction and a bridge.

Before toothache occurs there is the choice between (1) neglect and toothache or (2) care and its prevention.

* * * * *

The attitude of some people seems to be, figuratively speaking: "Millions for cure, not a cent for prevention." Dentistry cannot help such people much.

* * * * *

A pulpless tooth showing no radiographic evidence of disease seems a safe enough risk as long as the patient is healthy. But let the patient develop one of the degenerative diseases and it immediately becomes an "object of suspicion" and "a source of worry."

* * * * *

The interproximal examination as herein described is not a "happy find," a sudden discovery stumbled on by chance. It is the result of a deliberate and prolonged effort to develop a certain type of x-ray examination, the need for which is obvious, and has existed for a long time and seems to grow more acute as our knowledge of disease develops.

* * * * *

The *idea* for the radiographic interproximal examination is not new, but the technical method described here and the manner suggested for its application to the practice of dentistry are I believe.

* * * * *

Surgery is spectacular, but the ordinary filling in the tooth is the finger in the dyke.

* * * * *

When all the pulpless teeth are extracted—have you helped the patient? Or if you left some pulpless teeth in the mouth—are you sure you have been fair to the patient?

Difficult questions, those. But if you prevent toothache, if you place a restoration—ah, that is real service.

* * * * *

One reason people hate to pay dental and medical bills is because they do not figure on having them. Such bills for the most part come unexpectedly to the patient, and interfere with other plans. Regular interproximal examinations will tend to make people figure on a dental bill.

* * * * *

The problem of teaching the application of modern surgical principles to pulp canal surgery in a college clinic is even more difficult than their application in a dental office. Some colleges flounder rather terribly.

* * * * *

The presence of dead teeth in mouths of healthy people does not prove them harmless. Soldiers who have been shot at many times are still alive and unharmed. This does not prove that there is no danger in being shot at.

* * * * *

Once toothache occurs, the best one can do from there on is to "make the best of things," "do the best we can." Ominous phrases, these.

* * * * *

I don't mean to say that all pulpless teeth should be extracted or that we should quit treating teeth altogether, but I do mean to say that we are far too lax in our efforts at prevention.

* * * * *

You doubt whether the interproximal x-ray examination will ever be used, as I suggest, in the practice of dentistry? You may be right, but I point out to you that ten or fifteen years ago few thought that dentists would use radiograms extensively for diagnostic purposes. At that time I was tolerantly smiled at when I suggested that dentists would have x-ray machines in their own offices, and I was scolded when I suggested that radiography be taught in colleges.

* * * * *

After dentistry has sufficiently warned the public of the danger of toothache, and made sufficient effort to prevent it, then it may have the face to charge practical fees for aseptic canal work or advise extraction. Until then, toothache is largely the fault of the profession, and so the profession should make sacrifices to care for those who get it.

* * * * *

What Happened to Mrs. Jones

(Fiction with a Foundation of Fact)

"It's right in there, Doctor." Mrs. Jones indicated the spot in her mouth with her finger.

The dentist searched diligently.

"I don't find a thing. You have rather good teeth, Mrs. Jones."

"I just know there is something the matter with my tooth and Dr. Dig can't find anything," Mrs. Jones complained to her husband. "I've been to him twice. And each time he tells me he sees nothing wrong and asks me to come back if it doesn't get better."

"Why don't you go to my dentist, Dr. Pick?" This from Mr. Jones.

. . . .

"It's right there, Doctor." Mrs. Jones indicated the spot in her mouth with her finger.

Dr. Pick searched diligently.

"I don't find a thing." . . . .

One month later Mrs. Jones awoke with a terrific toothache. She went to Dr. Dig. For a long time Dr. Dig continued his examination, tapping this tooth and that, passing silk floss between the teeth, reaching between the teeth with slender instruments, from first one side then the other.

Finally he said, "I believe there is a cavity in that upper molar away beneath the gum and in between the teeth. Suppose we have an x-ray picture made to be sure."

The picture was made, and sure enough, there was a big cavity exposing the pulp, just as Dr. Dig had suspected.

The tooth was treated and filled. The treatment was difficult and the filling was large and so was the bill, or so Mrs. Jones thought at the time.

Four years later Mrs. Jones developed rheumatism in her fingers. It was most distressing for Mrs. Jones was a pianist of skill. She commenced to "make the rounds," going to first one man, then another. She took much medicine and followed much advice about her diet.

In due course of time the tooth that Dr. Dig had filled was radiographed. There was difference of opinion among dentists and physicians as to whether the radiogram revealed disease or not, but in view of the fact that no other cause for the rheumatism could be found by the physicians in charge, it was finally extracted. The extraction was rather expensive, for the tooth broke and its removal was quite difficult, and "curettement of the diseased bone was found necessary."

Then a bridge had to be made to replace the lost tooth.

Finally all the bills were paid—the family physician's bill, the medical diagnostician's bill, the laboratory's bill, the druggist's bill, the family dentist's bill, the radiodontist's bill, the exodontist's bill. When added up it was quite a sizable sum.

The progress of the rheumatism was stopped, but Mrs. Jones had to give up her music. Her fingers were no longer equal to the exacting requirements of the piano technic.

Mrs. Jones was open to conviction when Dr. Look, Dr. Dig's esteemed colleague down the hall, explained the necessity of periodic interproximal radiographic examination. Mrs. Jones' two children who are now in high school go to Dr. Look regularly.

Speaking of the necessity of filling cavities before they reach the pulp, Erwin once said, "It is easier to blow out a match than to extinguish a conflagration."

* * * * *

A Case from the Practice of a Radiodontist

Young man, thirty-three, married, four children. Had never been strong but had always been able to work until a month ago, when he had what was diagnosed a "nervous breakdown," since when he had not been able to attend to his work.

The radiodontic examination disclosed the presence of several pulpless teeth, none of which, however, showed definite evidence of periapical disturbance, though two showed questionable evidence of periapical bone change.

As no other probable cause of the breakdown was discoverable, it was decided to start dental treatment by the extraction of the two most suspicious teeth.

Prognosis, doubtful to fair.

And that is a rather typical radiodontic case.

The particularly unfortunate thing about the extraction of pulpless teeth is that the inescapable necessity for extraction so often develops at such an inopportune time: when the poor patient is already loaded down with sickness and worry and debt; when to add to the existing load the strain and distress and shock of extraction of teeth seems almost brutal. And yet not to extract may be disastrous to the health and life of the patient.

I have so often seen tuberculous patients who were already carrying a terrific load of distress have added to their troubles the necessity or expediency of tooth extraction. It is worse to be kicked when "down"; worse to have to have teeth extracted when sick.

A pulpless tooth in a sick person's mouth may be innocent, perhaps is *probably* innocent, but it is a source of worry to the conscientious practitioner of the healing art as long as the patient remains ill.

* * * * *

If it is the duty of the medical profession to prevent typhoid fever (and it is), it is no less the solemn duty of dentistry to prevent pulp disease (toothache) and the long train of trouble, disease and distress that follow in its wake.

* * * * *

Proof that Dentists Do Not Find Proximal Cavities

I have already advanced arguments and submitted some evidence to indicate that dentists do not find proximal cavities and other interproximal lesions. But perhaps I have failed to convince those who are difficult to satisfy. For the benefit of this group the following experiment was made.

A young lady in her early twenties with a "pretty good set of teeth" was selected for the patient. An interproximal x-ray examination of her mouth was made which revealed the following:

One large proximal cavity in a mandibular premolar.
Two medium-sized proximal cavities in premolars.
Two very small proximal cavities in mandibular molars.
One proximo-occlusal filling failing at the cervical.
One proximo-occlusal filling with large "overhang" into the proximal space.
In all, seven findings. See Fig. 41.

Following the examination the plan was to send the patient to at least ten dentists, selected at random, for examination. She was instructed to say something like this to each dentist. "Doctor, will you please examine my teeth for decay. I have them examined every six months, and it has been six months since they were examined last."

The patient was further instructed to ask specifically if any cavities were found "between the teeth" and if so "between which teeth." She was to note the time consumed for the examination and record the fact whether the dentist asked if any of her teeth "seemed to bother her," etc., etc.

The first day she visited four dentists and turned in her report. Then I seemed to detect an unwillingness on her part to go on. It finally developed that she had observed that, though the first dentist who examined her mouth had some difficulty in getting an explorer in a simple occlusal cavity or two, the insertion of the explorer seemed to become progressively easier. She assumed, not illogically, from this that the small cavities in her teeth were being made large by the instrumentation of the repeated examinations.

By the time the fear of injury had been allayed the patient found it necessary to leave town. She promised to continue the experiment and report to me. In the meantime I find it necessary to submit these articles to the printer. So I report what evidence I have at hand now. If a further report from the patient is available before publication, it will be appended hereto.

Dentist No. 1 took ten minutes for the examination. He located the one large proximal cavity but none of the six other interproximal findings which were revealed by the x-ray examination.

Dentist No. 2 took about eight minutes for the examination. He was "suspicious" of the one large proximal cavity but said he could not be absolutely sure there was a cavity. He failed to locate any of the six other findings. He used silk floss.

Dentist No. 3 took fifteen minutes to the examination. Noting the discoloration on the occlusal over the large proximal cavity, this man, to my surprise, advised the making of a radiogram.

Dentist No. 4 took about seven minutes to the examination. He found

Fig. 41.—Arrow *1*, points to a rather large proximal cavity in the distal of a mandibular second premolar. Arrows *2* and *3* point to medium-size proximal cavities. Arrows *4* and *5*, point to very small proximal cavities. (Filling of these cavities is not indicated now, but they should be kept under periodic x-ray examination, say at about one year intervals.) Arrow *6*, points to an area of decay at the cervical margin of a proximo-occlusal. Arrow 7 points to a big overhang of metal into the proximal space.

This is the case which, after interproximal x-ray examination, was sent to several dentists for the ordinary ocular and instrumental examination. Of the seven findings revealed by the x-ray examination, most dentists found only one; the cavity indicated by Arrow *1*. Some did not find or were uncertain of even this one and only two men—one of whom was in on the secret and so knew that he was being subjected to a test—even suspected anything further. These men were suspicious of the presence of the cavity indicated by Arrow *2*. For a full report of these examinations, see the text.

the large proximal cavity but failed to locate any of the other six findings revealed by the x-rays. He used an electric mouth light.

In addition to the four dentists who examined the mouth without knowing they were being put to a test, two who knew of the experiment, but were as yet unaware of the x-ray findings, also made an examination.

Of these two, one took thirteen minutes to the examination, the other ten minutes. One found only the large cavity, the other found the large cavity and was suspicious of one of the medium-sized proximal cavities.

The situation then up to date is that, of the six dentists who have examined the case, five located only one of the seven interproximal findings revealed by the x-rays, while one (one of the two who were in on the secret) located two of the seven findings.

It will be noticed that the time consumed for these examinations ranged from seven to as long as fifteen minutes. If the operator is "organized" it requires five or ten minutes to make exposures for the five-film interproximal examination and, except in cases of especial trouble, only a little longer for the seven-film examination. . . . .

Since writing the foregoing I have received a report from the patient on three more dentists. These last three are dentists of a large city. They do not seem to take as much time to an examination in the city.

This last report is in the form of a letter. The quotation marks I use indicate verbatim quotations from the letter.

Dentist No. 7 "took about four minutes. He asked no questions, didn't advise x-ray and found the" large proximal cavity. "He advised a new filling to replace an old one on the lower right." This filling "on the lower right" was not the one with either the faulty cervical margin or the big interproximal overhang. So this dentist located only one of the seven findings revealed by the x-ray examination.

Dentist No. 8 "took between three and four minutes, asked no questions, didn't advise x-ray, and just advised fillings in a few pit cavities. He didn't mention any cavities between the teeth."

Dentist No. 9 took "between four and five minutes, asked no questions, didn't advise x-ray." He found the large proximal cavity and "suspicioned" one of the medium-sized proximal cavities, the same one the presence of which was suspected by one of the two dentists who were in on the secret and examined the mouth.

A report on one more dentist reaches me. This man "asked if any teeth had caused me trouble, was about three minutes checking them over and found only one pit cavity. He spent some time examining around the big cavity" (a proximal one) "but said nothing about it."

Summary: Counting the two dentists who were in on the secret we now have a report on ten dentists. Of these ten, two found two of the seven interproximal findings; six found one of the seven interproximal findings, and two found none of the interproximal findings.

* * * * *

Prevention of Pyorrhea

Little has been said in this discourse thus far about the use of the interproximal examination in connection with the prevention of pyorrhea. One reason for this is that my main interest is in the prevention of toothache, and so the prevention of the pulpless tooth and the systemic diseases caused by such teeth. This kind of prevention is quite obviously within our reach; all we need to do is to act; the results are assured.

The prevention of pyorrhea, on the other hand, has, until recently, seemed hopeless, or at least discouragingly uncertain, to me. Recent developments, however, renew my hope. If I understand the leaders in this branch of dentistry, we as a profession have been failing utterly to diagnose pyorrhea until it has reached an advanced stage, when the results from treatment have certainly been none too satisfactory.

Now I hear it stated definitely that pyorrhea *begins* in the *alveolar crest* and that evidence of this beginning *can be seen in radiograms* in time so that suitable treatment—restoration to normal functional occlusion, etc.—can be applied in time to permanently stop its further development. If this is true, the interproximal x-ray examination is destined to play as great a part in the prevention of pyorrhea as I have shown that it will play in the prevention of the pulpless tooth.

ABSTRACT OF
CURRENT LITERATURE

Covering Such Subjects as

ORTHODONTIA — ORAL SURGERY — SURGICAL ORTHODONTIA — DENTAL RADIOGRAPHY

It is the purpose of this JOURNAL to review so far as possible the most important literature as it appears in English and Foreign periodicals and to present it in abstract form. Authors are requested to send abstracts or reprints of their papers to the publishers.

Orthodontia for the General Practitioner. P. N. Williams (New York). The Dental Digest, July, 1925, xxxi, 7.

Although this subject may be said to have been worn threadbare in dental papers the author wishes to discuss it from a standpoint which is somewhat novel. The ordinary practicing dentist in the small community ought to know enough about orthodontia to render certain services to his clientele. He ought, for example, to be able to remedy certain simple defects. The first of these to have in mind is the disturbance caused by obstructed nasal passages. The author believes that this deformity originates in the buccal cavity from a too high and narrow arch which pushes up the superjacent structures and thus bends the septum. In this condition ordinary anomalies of implantation may be quite absent. Differing as it does from ordinary orthodontia it is, nevertheless, treated in a similar manner by spreading the maxillary jaw.

In regard to orthodontia proper the dentist knows that crowded, overlapping and irregular teeth originate from arrested development of the alveolar process. Before proceeding to treatment he must locate the seat of this arrest, for it is more or less localized. It may then be possible to stimulate the growth of this backward area. It is impossible to arrive at the actual alignment of the teeth without plotting the arch by wax impression and this defective arch should be compared with a normal one. It will then be possible to make an exact diagnosis and apply the proper remedy. Plaster impressions of the models in wax should next be taken. The article will be continued.

Etiology of Gingival Pathology. N. M. Gassen (New York). The Dental Outlook, July, 1925, xii, 7.

The author, who is chief of a pyorrhea clinic, begins by mentioning two schools of belief in which the cause of pyorrhea is put either within or without the mouth. This naturally affects the treatment which may either be purely local or very largely constitutional. Strange to say compromise views are uncommon and of rather recent origin but a third school is in the process of development in which both local and constitutional factors are duly honored in practice. In order to get the proper perspective of the subject the author studies it from the historical viewpoint. Even from the first it seems to have

been understood that the causes of tooth pathology were distinct from those of gum pathology.

Eustachius, the old anatomist, was far ahead of his time when he recognized analogies between the teeth and nails, each growing from a soft tissue. He knew of the recession of the gums and apparent elongation of the teeth in elderly people and explained it very simply by their defective nourishment which leads to a physiologic atrophy of the gum. Ruysch studied the atrophy of the alveolus which follows extraction and also noted that a constitutional disease, scurvy, could cause a striking affection of the gums. Fauchard was the first to write of pyorrhea which he regarded as an affection involving alike the gums, alveoli and teeth and he recognized that the suppuration of this condition must mean an irritative causal factor. John Hunter recognized that pyorrhea was a disease of the alveolar process—a primary atrophy of it which was followed by retraction of the gum and filling up of the alveolar pocket. The priority of Riggs—who probably knew nothing of the pioneer work of Fauchard and Hunter—lay in the fact that he found a method for combating this affection in practice. This consisted essentially in the evacuation of the pockets, chiefly of the salivary calculus deposited upon the necks of the teeth. In 1867, the year in which he was invited to describe his method before the Connecticut Valley Dental Association, the resolution of thanks mentioned the affection as a "scurvy of the gums," showing that that designation must have been in use at that period among both dentists and laity but for no better reason than that the teeth loosen in both maladies. Riggs was clearly a localist and the great influence which he has exerted on his followers is largely responsible for the persistence of the purely local school.

Nevertheless, there must be constitutional factors and among these senescence must first be mentioned; next should come errors of development which are a general predisposing cause of disease. Defective diet is a third factor. The rôle of severe constitutional disease may be mentioned, since at least, this acts by inducing a premature senescent condition. Numerous local predisposing causes have also been isolated, prominent among which is malocclusion and the consequence that some teeth have little chance for exercise and thus tend to undergo involutional changes.

The relation of senile recession of the gums and loosening of the teeth to pyorrhea has long been a puzzle. Hopewell-Smith has recently shown that the alveolus is at the maximum of development at about the age of twenty-five years and that from that period involution slowly begins. But precocious senescence can hardly be more than a predisposing factor in pyorrhea. Why are there so many old men without a suggestion of the latter?

The article will be continued.

Adventitious Dentins and Infection of the Dental Pulp. A. Hopewell-Smith (Philadelphia). Dental Items of Interest, July, 1925, xlvii, 7.

The editor of this journal, Dr. Ottolengui, in an editorial entitled "Practical Import of Papers," gives some of the more striking extracts from this paper. After speaking of the honor of being able to publish so valuable a contribution the editor takes up the practical value of this as an example of

laboratory study often passed over by the casual reader as technical and theoretical. It is true that this kind of article has no nourishment for the mechanical dentist but practical matters concern the head no less than the hand. One practical problem has to do with the safe retention of pulpless teeth and on this point Dr. Hopewell-Smith shows plainly that the tooth with injured pulp can never undergo any kind of regenerative process because of the absence of a collateral circulation while the very common venous stasis gives rise to an entire series of morbid processes.

Another very important point refers to the chance of pulp infection. The tubular nature of dentin and the character of the millions of channels present a condition very favorable to infection. It is not very well known that the pulp can even be infected before it is exposed although the condition is readily shown in microphotographs. Infection cannot possibly occur through normal cementum. There is grave doubt as to the possibility of an infection of the pulp through the blood stream. Still another point has reference to "accessory foramina" due to anomalous development of the root. These are wrongly named for they have no relationship with the pulp cavity and contain no pulp. Its only content is an arteriole and possibly a pair of venules.

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EDITORIALS

American Medical Association Discontinues the Section of Stomatology

AT the meeting of the American Medical Association at Atlantic City, May, 1925, the Council on Scientific Assembly turned in the following report.

"For a number of years, one of the regular sections of the Scientific Assembly has been the Section of Stomatology. The registration at the meetings of this section has been consistently small, so that at no time has there been a sufficient number of orders for the transactions of the section to justify publication. The programs of the Section on Stomatology are tending more and more each year to deal with *oral surgery and subjects pertaining to general medicine.* It is the sense of the Council on Scientific Assembly that the Section of Stomatology be abolished and that when, in the opinion of the Council, it may be advisable, sessions on stomatology shall be held in the Section on Miscellaneous Topics. The Council recommends to the House of

Delegates that the action indicated above shall be taken at this session and that the by-laws be amended accordingly."

The recommendation of the committee was accepted by the House of Delegates and the Section of Stomatology ceased to exist. The discontinuance of this section is more or less of an insult to the dental profession but probably was made advisable by existing conditions, some of which are outlined in the report of the committee.

The portion of the report which refers to the fact that the program of the Section of Stomatology "tended more and more each year to deal with oral surgery and subjects pertaining to general medicine," is quite true. The reason for this is that the section gradually passed beyond the control of Associate Fellows of the American Medical Association, holding the dental degree only. The Section of Stomatology was primarily organized for the purpose of bringing prominent men of the dental profession into the American Medical Association as Associate Fellows. The requirements for admission were that the applicant should be a member of the local dental society and a member of the National Dental Organization, which necessarily implied that he must be in good standing in the profession. In spite of the qualifications for membership as outlined in the constitution and by-laws of the American Medical Association, a group of men obtained control of the Section of Stomatology and set up its own qualifications for membership. We have known of men of good standing in the dental profession, even men who hold professorships in colleges, applying for admission to the Section of Stomatology and being turned down by those in charge regardless of the fact that the applicants possessed all qualifications required by the constitution and by-laws of the American Medical Association. It was also made known that a man possessing only a degree of Doctor of Dental Surgery would not be invited to read a paper in the Section of Stomatology. As already stated by the Council of Scientific Assembly, the program tends each year to deal with oral surgery and subjects pertaining to general medicine. With the requirements for membership that were set by men who were in control of the section, it is no wonder the council was impressed with the slight increase in members and the small attendance at each session. The Section of Stomatology was woefully mismanaged according to the by-laws of the American Medical Association. The section at one time had an illegally appointed Nomination Committee which had the audacity to nominate two-thirds of their members for offices in the section. When the attention of the chairman was called to the fact that the Nomination Committee must be composed of the Executive Committee, the Executive Committee followed the same procedure by nominating two-thirds of their members for offices in the section. This action was so disgusting that many members of the section withdrew and allowed it to remain in the hands of the "Close Corporation" which succeeded in running it so badly that the Council on Scientific Assembly discontinued the section.

In the report of the council we read that the attendance has been small, which statement the Council on Scientific Assembly did not analyze well. In the *Journal of the American Medical Association* of June 6, 1925, there is pub-

lished a list of the applicants of associate fellowship in the various sections:

"Section of Pharmacology and Therapeutics had two applicants.

"Section of Pathology anl Physiology had two applicants.

"Section of Stomatology had eleven applicants for fellowship.

"Section of Preventive and Industrial Medicine and Public Health had two."

The Section of Stomatology had nearly twice as many applicants as had three other sections of the American Medical Association which were not discontinued.

According to the action of the council, papers on stomatology and applications for Associate Fellowship in the American Medical Association in the future, are to be handled in the Section of Miscellaneous Topics. It is interesting to note according to the registration by sections, stomatology had thirty-four at the Atlantic City session and the Section on Miscellaneous Topics had only fifty-seven and out of the fifty-seven, the majority of registrants came from radiography. Prior to the meeting in Atlantic City, the American Medical Association did not have a section on Radiography. This was created at Atlantic City and the membership and registrants in the Miscellaneous Section will be greatly reduced by the radiologists attending their own section.

We also note that the Section on Pharmacology and Therapeutics had a registration of thirty-eight which was only four more than the Section of Stomatology.

We consider the action of the House of Delegates, in discontinuing the Section of Stomatology, is a move which will tend to separate further the medical and dental professions at a time when educational authorities are trying to bring closer cooperation between the two. The Council on Scientific Assembly was ill advised as to the real reason that the dental profession did not take a greater interest in the Section of Stomatology and as to why the membership did not increase as the officers of the American Medical Association thought it should. We believe the discontinuing of the section was the result of the council's misunderstanding the real attitude of the profession towards it. The apparently lethargic attitude of the dental profession arose from the fact that the Section of Stomatology was conducted for a number of years contrary to the by-laws of the American Medical Association. This mismanagement of the section, by a few, was disgusting to the rank and file of the dental profession.

The Scientific Foundation and Research Commission in the American Dental Association

AT the meeting of the American Dental Association in Dallas, changes in the constitutional and administrative by-laws, which will greatly affect the Research Commission, were proposed. If the commission is to continue as an organization that will be a credit to the dental profession, the proposed changes should not be passed. From a careful study of the activities of the

Research Commission and its relation to the dental profession during the past three years, it seems to indicate that someone in the American Dental Association does not understand the work and the purpose of this institution. It is necessary to have some idea of the manner of establishment and the work carried on by the Research Commission in order to realize that the proposed changes would be very detrimental to it as organized scientific research in the dental profession would be practically killed.

As a matter of history, several years before the organization of the American Dental Association, there was created in the National Dental Association, a Scientific Foundation and Research Commission which was included in the American Dental Association when it was formed by the certificate of incorporation, under the date of June 19, 1922. The constitutional by-laws drafted at that time contain the following statement in Article 7: "The association shall organize and maintain a Scientific, Foundation and Research Commission of twenty-five members who shall be elected by the Board of Trustees." The Administrative By-Laws of the same date in Chapter X, outlines the function and duties of the Scientific Research Commission as follows:

"Section 1: This commission shall consist of twenty-five members, who shall be elected by the Board of Trustees, not more than three of whom shall be from one state. In addition to the twenty-five members elected by the Board of Trustees, the president, president-elect and general secretary shall be ex-officio members. They shall serve for five years, five being elected each year. They shall meet annually at the time of the annual session of the American Dental Association and at such other times as shall be designated by their Executive Board.

"Section 2: The duties of the commission shall be to raise funds for carrying on exhaustive dental and oral research to disseminate scientific knowledge; to support, establish and encourage research and such other duties as shall pertain to the furthering of this cause. They shall elect from their number an Executive Board of five members which shall, when the commission is not in session and has not given specific directions, have general control of the administration of the affairs of the commission and general supervision of all arrangements for administration, research and other matters undertaken or promoted by the commission. They shall organize and incorporate a corporation to be known as the 'Research Institute of the American Dental Association' which corporation shall receive, invest, and disburse the moneys provided by the commission and by themselves. They shall organize this corporation in accordance with the laws and requirements controlling such institutions, except that not less than one-third of the trustees of said corporation shall be provided by the American Dental Association. This corporation shall seek bequests, endowments, fellowships and such other contributions as shall perfect the purpose and plan of the American Dental Association. They shall make a written annual report and financial statement to the commission and to the American Dental Association."

It will be noticed in Section 1, that the membership of the commission was carefully guarded by having five men selected each year to serve five years. This made the committee sufficiently large and democratic to be able

to view conditions from all angles and to report upon and study research in all parts of the United States.

Under Section 2, Chapter X, the duties of the Research Commission are carefully outlined, which are the "carrying on of the exhaustive dental and oral research; to disseminate scientific knowledge; to support, establish, and encourage research, and such other duties as shall pertain to the furthering of the cause." Section 2, provides for an Executive Board of five members to act when the Commission is not in Session. It also provides that, the Commission "shall organize and incorporate a corporation to be known as a Research Institution of the American Dental Association which corporation shall receive, invest and disburse the moneys provided by the commission and by themselves. They shall organize this corporation in accordance with the laws and requirements controlling such institutions, except that not less than one-third of the trustees of said corporation shall be provided by the American Dental Association. This corporation shall seek bequests, endowments, fellowships and such other contributions as shall perfect the purpose and plan of the American Dental Association."

It seems that the rank and file of the dental profession were unfamiliar with that part of the duties of the commission relative to the incorporation of the Research Institute of the American Dental Association and its purpose. We do not know who wrote Section 2 of Chapter X, but it was evidently written by someone familiar with the organization of Research Institutes, who knew the necessity of having such an institute and who realized the importance of a plan that would make it possible to get endowments and bequests from wealthy individuals. To obtain endowments some organization must exist, the future of which is permanent. By having the Research Institute as provided for in Chapter X, Section 2, sums of money can be handled by the same individuals year after year.

It seems to me that someone in the American Dental Association deliberately tried to hinder the action of the Research Commission and Scientific Foundation by interfering with the Research Institute of the American Dental Association. This is substantiated by the report of the Transactions of the American Dental Association of the sixty-fifth annual session, held in Cleveland, Ohio, September 10, 11, 12, 14, 1923.

The president of the American Dental Association in his address at Cleveland, Monday, September 10, referred to the Research Commission and Research Institute in terms which clearly indicated he was unfamiliar with the plan of organization of the Research Institute of the American Dental Association. His unfamiliarity seems to be inexcusable when the information could have been so easily obtained. On Wednesday afternoon, September 12, Dr. Weston A. Price made a report to the House of Delegates covering the questions raised by the president in his address. Instead of Dr. Price's report satisfying the president of the American Dental Association, we find that the president at a later session of the House of Delegates called Vice-President Cudworth to the chair so that the president might make a motion. It was unusual for the president to call the vice-president to the chair in order that

the president might make a motion which should have been made by some member of the House of Delegates. The motion made by President Buckley was entirely out of order and was null and void because the president of the American Dental Association is not a member of the House of Delegates. No one except members of the House of Delegates have the right to make a motion. Furthermore, such a motion by a member of the House of Delegates would have been entirely out of order because according to Chapter X, Section 2, "the Research Institute of the American Dental Association is given absolute control to receive, invest and disburse moneys provided by the commission and by themselves." Also the Research Institute was provided for in the administrative by-laws as created by an act of incorporation; therefore, the action of the Research Institute was accurately defined. The administrative by-laws cannot be interfered with by a motion made by any member of the House of Delegates. The purpose of the act of incorporation was to prevent just such a thing as the president did at Cleveland and was to prevent similar action being taken at any other time by any members of the House of Delegates.

There has never been any question as to the proper management of the Research Institute from a legal standpoint. It is true there have been some personal jealousies which undoubtedly were the result of the making of the motion instructing the Board of Trustees to interfere with the Research Institute. All action taken by the Board of Trustees as a result of the motion was illegal because the by-laws gave them no such power. The Research Institute is the best possible means for providing for research work that will be a credit to the American Dental Association. The proposed amendment to Chapter X of the administrative by-laws will absolutely ruin the Research Commission of the American Dental Association because no individual with any self-respect will serve on the commission. The amendment takes research out of the hands of the Research Commission and places it under the control of the Board of Trustees. The Board of Trustees and the general secretary of the American Dental Association have more duties than they can properly perform without interfering with research.

The first serious objection to the proposed amendment is that the Research Commission is reduced in size from twenty-five to five members—a commission entirely too small for the purpose. Section *B*, of the proposed amendment Chapter X, reads as follows:

"Section *B:* The Commission shall organize, shall elect a chairman and secretary, and shall adopt such regulations for the government of its actions, not inconsistent with these by-laws, as it may find from time to time expedient. The secretary shall keep a continuous record of its proceedings and report from time to time its recommendations through the secretary to the Board of Trustees, and make an annual report to the Board of Trustees."

Section *C* provides that the commission shall receive applications in writing from persons soliciting funds for themselves or for others shall invest by themselves or by their agents all applications, and shall require such proof or verifications as the commission may deem proper, shall pass upon such

applications recommending or disproving them in whole or in part and report their recommendations through the general secretary to the Board of Trustees, stating the amount of the grant recommended, the time or times for payment, and the person or persons to whom it may be made payable. It will be seen that Section *C* places the ultimate control of research with the Board of Trustees which is further carried out by Section *D;* "Which if approved by the board the usual order of payment out of the proper Research Fund shall be made out by the General Secretary, which if found correct, shall be countersigned by the Secretary of the Research Commission and paid by the Treasurer."

The action of the Research Commission is further curtailed by Article *E,* of the proposed amendment which says, "Research Commission shall undertake and superintend such research work, as the Board of Trustees shall from time to time authorize." Article *E,* practically makes the Board of Trustees the Research Commission. The Research Institute as provided for in the present administrative by-laws necessarily ceases to exist because Chapter X of the proposed amendment does not provide for its continuation. There is no provision for obtaining bequest, endowments, and fellowships to be used in research. In fact, research is destroyed as an organized institution by failure to provide for the continuation of the Research Institute of the American Dental Association.

Regardless of the fact that the proposed amendment practically ruins research it is dangerous because it places research under the control and power of the Board of Trustees, which already has more business than it can attend to without attempting to control research.

We hope every member of the American Dental Association and every delegate of the House of Delegates in the American Dental Association will carefully study the proposed amendment to Chapter X, of the administrative by-laws and make himself familiar with the present by-laws in order to be able to vote wisely on the proposed amendment that will come up at Louisville. It is our belief that everybody who wishes to kill the "Research Commission" should vote for the amendment in Chapter X. The Research Commission is for the purpose of receiving funds, and such funds as may come to it it should be allowed the privilege of distributing in such a manner as to produce the greatest good for the American Dental Association.

ORTHODONTIC NEWS AND NOTES

American Board of Otolaryngology

An examination was held by the American Board of Otolaryngology on May 26, 1925, at the Medico-Chirurgical Hospital, Philadelphia, with the following result:

Passed	137
Failed	20
Total Examined	157

The next examination will be held at the University of Illinois School of Medicine on October 19, 1925. Applications may be secured from the Secretary, Dr. H. W. Loeb, 1402 South Grand Boulevard, St. Louis, Missouri.

First District December Meeting

The First District Dental Society of New York announces a three-day meeting to be held December 2, 3, 4. It is planned to make this an annual feature of the winter program of this Society. The program will contain a carefully selected list of essays by dentists and physicians of national reputation, and clinics by leading exponents of the various specialties of dentistry. The watchword of the meeting will be *Better Dentistry,* and no effort will be spared to make this meeting definitely helpful to every one who attends.

All Sessions will be held in the Hotel Pennsylvania. Exhibits will be featured and opportunities for their inspection will be provided.